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By ROBERT E. ELBEL

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AMBLYCERAN MALLOPHAGA (BITING LICE) FOUND ON THE BUCEROTIDAE (HORNBILLS) [1]

By Robert E. Elbel [2]

Mallophaga of the genera *Chapinia* and *Bucerophagus* of the amblyceran family Menoponidae are found only on hornbills. The purpose of this paper is to redescribe and illustrate the known species in these genera, describe new species encountered, and compare the classification of these lice with that of the hornbills. Menoponidae have been examined from 53 species or subspecies of hornbills (table 13). Presented are descriptions and illustrations of 22 species of Menoponidae of which 17, including 12 new, are species of *Chapinia*, 3 are species or *Bucerophagus*, and 2 are new species in a new genus, *Bucerocolpocephalum*.

No previous attempt has been made to examine all the Menoponidae from the hornbills. Clay (1947) included *Chapinia* and *Bucerophagus* in her key to the genera of the Menoponidae, but her figures 8 and 9 of the antennae of these genera were transposed accidentally. The genus *Chapinia* was described by Ewing (1927) for his species *C. robusta;* later it was described by Bedford (1930) for *Menopon bucerotis*

[1] Modified from a doctoral dissertation submitted to the University of Oklahoma, Norman.

[2] E. and E. Branch, Dugway Proving Ground, Dugway, Utah.

Kellogg, 1908, and *M. lophocerus* Bedford, 1920. Hopkins and Clay (1952) included in the genus *Chapinia* the additional species, *Colpocephalum hirtum* Rudow, 1866, *Menopon acutovulvatum* Piaget, 1881, and *Allomenopon mjöbergi* Eichler, 1947, but they considered the generic position of *C. hirtum* doubtful. In the present study *C. hirtum* is shown to be a *Chapinia*, and a neotype is designated; *A. mjöbergi* is shown to be a synonym of *M. acutovulvatum*. Hopkins (1941) designated a lectotype for *Chapinia lophocerus* (Bedford), Clay (1949a) designated a lectotype for *C. acutovulvata* (Piaget), and a lectotype is designated here for *C. bucerotis* (Kellogg). Piaget (1880) identified a female from *Rhyticeros cassidix* (Temminck, 1823) as *C. hirtum*, but Piaget's specimen is shown here to be the new species *Chapinia lydae*. The genus *Bucerophagus* was described by Bedford (1929) for his species *B. africanus* and for *Colpocephalum productum* Burmeister, 1838. For the latter species a neotype was erected by Conci (1950), and a lectotype was designated by Clay (1951a). Eichler (1947) described a new genus for *Menopon forcipatum* Nitzsch, 1874, but Hopkins and Clay (1952) put *M. forcipatum* in the genus *Bucerophagus*. A neotype for *B. forcipatus* (Nitzsch) is designated here from Eichler's material. Clay (1951a) stated that *Bucerophagus africanus* and *B. productus* both infest the two hosts, *Bucorvus abyssinicus* (Boddaert, 1783) and *B. leadbeateri* (Vigors, 1825). No morphological or statistical means were found in the present study to separate the populations of each species on each host so that only the two species, *Bucerophagus productus* and *B. africanus*, could be recognized.

The phylogenetic arrangement of the hornbills (Peters, 1945) shows scant regard for the geographical regions, and the list winds back and forth between the Ethiopian, Oriental, and Australasian regions (table 13). The mallophagan genera studied here, however, fall into definite species-groups confined to the Ethiopian region or to the Oriental and Australasian regions. It is believed, therefore, that the arrangement of the Mallophaga gives more insight into the origin of the hornbills than study of the host skins.

Classification of the hosts is that proposed by Deignan (1963) except for species not discussed by him, for which Peters (1945) has been followed. Skins of the hosts collected in Thailand are in the U.S. National Museum and were identified by Mr. H. G. Deignan. Collections were made possible by assistance from the U.S. Operations Mission to Thailand and the U.S. National Museum.

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Explanation of Terms

The terminology used in this paper agrees with that of Clay (1947) except as noted below.

"Combs of setae" are rows of short, stout setae, each with the alveoli lying close together and approximately in a straight line, on the venter of the third femora and the posterolateral areas of one or more abdominal sternites (figs. 64, 65).

"Brushes of setae" are concentrations of setae on the venter of the third femora and the posterolateral areas of one or more abdominal sternites. These may take the form of a few widely spaced setae called "small scattered brushes" (figs. 23, 24) or a large number of closely set setae called "large thick brushes" (figs. 68, 69). The setae of the brushes are "normal" if approximately the same length and thickness as the surrounding setae or "small" if the majority are considerably smaller than the surrounding setae.

The "preocular slit" is an emargination with approximately equal and parallel margins in the dorsal-lateral margin of the head immediately anterior to the eye (figs. 23, 24).

The "preocular notch" is a similar emargination with triangular or semicircular margins (figs. 25, 26, 64–69).

The "metasternal plate" on the metasternum was first described by Bedford (1920) as a 4-sided plate which was normally expanded anteriorly (figs. 26c, 64c, 66c, 68c, 70).

The male and female each possess a complete complement of abdominal segments from the first to the tenth (Cope, 1941).

The "pleurites" ("paratergal plates" of some authors) are sclerites which pass around the lateral margin of the abdomen and are separated from the tergites and sternites by clear divisions (Clay, 1954) (figs. 23, 24).

The "postspiracular seta" on each side of abdominal tergites III–VIII is posterior to the spiracle and is always associated with two small setae, the alveoli of the three setae being contiguous (Clay, 1954). A similar group of three setae is present on abdominal tergite II, although there is no functional spiracle on this tergite. In most Amblycera the postspiracular setae are the most laterad setae of the posterior marginal row (fig. 25p).

The "male terminal abdominal tergites" IX and X are almost completely fused. "Abdominal sternite VIII" is fragmented into two parts which have moved laterad. "Abdominal sternite IX" strengthens the anterior lip of the genital and anal opening (cloaca), and there is no apparent tenth sternite (Cope, 1941).

The "basal plate" ("basal apodeme" of Clay, 1956) of the "male genitalia" supports posteriorly the slender "parameres" laterally and the "endomeres" centrally (Ewing, 1927).

The "sclerite of the male genital sac" is the sclerite on the walls of the genital sac which is articulated to the basal plate (Clay, 1956) (figs. 18s, 19s).

The "lateral horns" of the "male genitalia" are structures on each side of the large, curved, platelike "endomeres" (Ewing, 1927) (figs. 1–3, 6, 7).

The "female terminal abdominal tergites" IX and X are single plates. "Abdominal sternite VIII" has a pair of gonopods, lying side by side medially, which are fused at their apices to cover the genital opening (vulva) between segments VIII and IX, and on each lateral side of the gonopods is a fragment of sternite VIII (Cope, 1941).

The "internal sclerite of female abdominal sternite VIII" appears to be the sclerite that Clay (1961) calls the internal structure of the female genital chamber (figs. 35i, 38i, 39i, 49i).

"Sclerital hooks" are hooklike processes in the female arising on

either side of the midline of the "ventral sclerite between the vulva and anus" (fig. 27h).

The "anal fringe" ("anal corona" of Ferris, 1923) surrounds the female anus on abdominal segment X (figs. 28, 45, 52).

"Species-groups" are groups of similar species within a genus.

"Fresh material" indicates that Mallophaga were obtained from the host that was collected in the field as contrasted to mallophagan "dried material" which was obtained from dried museum skins either personally (REE) or by my wife, Lyda.

Methods

Dried material was obtained from museum skins by lightly fluffing the bird feathers, particularly around the neck and lower belly, over a white surface. Emerson (1954) stated that contamination that occurred on museum skins was well known and that records of Mallophaga so obtained should be considered questionable. Mallophaga that were obtained from museum skins were considered here to be stragglers unless they belonged to recognized hornbill genera and unless they were represented by other specimens obtained from additional skins or fresh material of the same host species. Correspondingly, about 20 percent of the dried material was considered to be stragglers. The mounting procedure was suggested by Dr. K. C. Emerson (in litt.): Mallophaga were placed in 10 percent potassium hydroxide overnight, transferred to distilled water, and after one hour the body contents were teased out. Specimens were placed in fresh 10 percent potassium hydroxide for 6–12 hours, after which they again were transferred to distilled water. Approximately one-half hour later specimens were put into 40 percent ethyl alcohol. Fifteen minutes later several drops of carbol fuchsin (Ziehl Nielson) were added and allowed to act for one-half hour. Specimens were placed in 70 percent ethyl alcohol for one-half hour, followed by 95 percent ethyl alcohol for 15 minutes. Next, specimens were washed in 100 percent ethyl alcohol for a few minutes and placed in Beechwood Creosote for one hour to overnight, after which they were mounted in Gum Damar or other dried resin media.

Drawings were prepared from holotypes and allotypes except as noted in the text. All drawings were prepared with the aid of a 300-watt, 35-mm. slide projector as suggested by Dr. K. C. Emerson (in litt.). The monocular microscope with the mounted Mallophaga was turned on its side, the ocular and mirror removed, and the slide projector placed at the lower end of the microscope so that the light projected the image onto a vertical surface, from which the outline was traced on Bristol board or drawing velum. Measurements were obtained by projecting a millimeter scale from a stage micrometer

onto the surface. Details of the Mallophaga were added after the microscope was uprighted.

Measurements for the tables are in millimeters and were made with the aid of an ocular micrometer.

Because of variation in setal number, setae recorded in species descriptions represent the range in numbers of setae from representative specimens from the material examined.

Characters described under genera or species-groups have not been repeated for individual specific descriptions. In each genus or species-group the arrangement of the species is based first on morphological similarity and second on the phylogenetic arrangement of their hosts.

Key to Species of *Chapinia*, *Bucerocolpocephalum* and *Bucerophagus*

1. Terminal segment of antenna showing definite signs of division either by transverse line or marginal indentation (figs. 64a, 66a, 68a) 19
   Terminal segment of antenna without signs of division (figs. 23a, 25a). (Genus *Chapinia* Ewing). . . 2
2. Dorsal-lateral margins of head with a preocular slit (figs. 23, 24). (*lophocerus* species-group) . . . 3
   Dorsal-lateral margins of head with a preocular notch (figs. 25, 26). . . . 7
3. Each lateral margin of abdominal tergites III–VI with a short seta between the spiracle and postspiracular seta (fig. 64 l) 4
   Abdominal tergites without such short setae (figs. 23, 24). **C. robusta** Ewing, p. 17.
4. Abdominal sternite II with three median rows of setae. **C. bucerotis** (Kellogg), p. 15.
   Abdominal sternite II with one median row of setae on posterior margin . 5
5. Male genitalia with each lateral horn possessing two sharp posterior points; female anal fringe with fewer than 58 setae (figs. 2, 28). **C. lophocerus** (Bedford), p. 13.
   Male genitalia with each lateral horn possessing one or two rounded posterior points; female anal fringe with more than 58 setae 6
6. Male genitalia with each lateral horn possessing two rounded posterior points; female anal fringe with more than 70 setae (fig. 1). **C. fasciati,** new species, p. 12.
   Male genitalia with each lateral horn possessing one rounded posterior point; female anal fringe with 60–64 setae (fig. 3) . **C. camuri,** new species, p. 15.
7. Each lateral margin of abdominal tergites III–VI with a short seta between the spiracle and postspiracular seta (fig. 64 l) 8
   Abdominal tergites without such short setae 11
8. Male genitalia with endomeres possessing small inner plate and paired outer rims, each with serrulations on posterior inner margin; female with each lateral projection of ventral sclerite between vulva and anus possessing more than eight thick, posteriorly directed setae (figs. 71, 72sp). **C. waniti,** new species, p. 22.
   Male genitalia with endomeres possessing small or large inner plate and paired outer rims without serrulations; female with each lateral projection of ventral sclerite between vulva and anus possessing fewer than eight thick, posteriorly directed setae (fig. 43sp) 9

9. Male genitalia with endomeres possessing paired outer rims and large shieldlike inner plate with paired lateral flanges and central terminal point; female abdominal sternite VIII with more than 32 setae on posterior margin (figs. 12, 37) . . . . . **C. malayensis,** new species, p. 25.

Male genitalia with endomeres possessing paired outer rims and small inner plate that is not shieldlike; female abdominal sternite VIII with fewer than 32 setae on posterior margin 10

10. Male genitalia with endomeres possessing on each outer rim a triangular internal knob wider than long; female terminal abdominal tergite with at most five long setae each side of midline on posterior margin (figs. 8, 33).

C. clayae, new species, p. 21.

Male genitalia with endomeres possessing on each outer rim a triangular internal knob longer than wide; female terminal abdominal tergite with at least six long setae each side of midline on posterior margin (figs. 9, 35).

C. acutovulvata (Piaget), p. 23.

11. Abdominal sternite II with at least two median rows of setae 16

Abdominal sternite II with one median row of setae on posterior margin.

(*acutovulvata* species-group) . . . 12

12. Male abdominal sternite II with more than 46 total setae; female anal fringe with more than 48 setae 13

Male abdominal sternite II with fewer than 44 total setae; female anal fringe with fewer than 46 setae 14

13. Male genitalia with endomeres consisting only of paired outer rims which are curved inwardly; female abdominal sternite VIII with internal sclerite almost as wide as long (figs. 13, 38i) . . . . **C. hoplai,** new species, p. 26.

Male genitalia with endomeres consisting only of paired outer rims which are straight and nearly parallel; female abdominal sternite VIII with internal sclerite much longer than wide (figs. 14, 39i).

C. boonsongi, new species, p. 27.

14. Male genitalia with endomeres consisting of paired plates having posterior extension split; female venter of third femora and abdominal sternites IV–VI without brushes (figs. 17, 25) . **C. traylori,** new species, p. 31.

Male genitalia with endomeres either lacking paired plates or, if present, posterior extension not split; female venter of third femora and posterolateral margins of abdominal sternites IV–VI each with brushes of normal setae 15

15. Male venter of third femora and posterolateral margins of abdominal sternites IV–VI each with brushes of normal setae; female abdominal sternite VIII without internal sclerite (fig. 40).

C. wenzeli, new species, p. 28.

Male venter of third femora and abdominal sternites IV–VI without brushes; female abdominal sternite VIII with internal sclerite having slender posteriorly divergent margins (fig. 43) . . **C. blakei,** new species, p. 29.

16. Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with brushes of normal setae 17

Venter of third femora and abdominal sternites IV–VI without brushes (figs. 25, 26) . . . . . **C. traylori,** new species, p. 31.

17. Male genitalia with parameres enlarged anteriorly; female terminal abdominal tergite with the two median setae on posterior margin as widely spaced as four times the distance between each of the 3–4 long setae each side of midline (figs. 20, 46) . . . . . **C. lydae,** new species, p. 32.

Male genitalia with parameres slender anteriorly.

(*hirta* species-group) . . . 18

18. Sclerite of male genital sac large, nearly twice as long as wide; female unknown (fig. 18s) . . . . . **C. muesebecki,** new species, p. 34.
Sclerite of male genital sac small, about as wide as long; female terminal abdominal tergite with 5 long setae on posterior margin each side of midline, these 10 setae being evenly spaced (figs. 19s, 48).
C. hirta (Rudow), p. 35.

19. Venter of third femora and posterolateral margins of fourth abdominal sternite each with three full rows of combs (figs. 64, 65).
(Genus *Bucerocolpocephalum*, new genus). . . 20
Venter of third femora and fourth abdominal sternite without combs.
(Genus *Bucerophagus* Bedford). . . 21

20. Male genitalia with endomeres having a pair of posterior points; female abdominal sternite VIII with internal triangular sclerite (figs. 49, 57).
Bucerocolpocephalum emersoni, new species, p. 37.
Male genitalia with endomeres lacking a pair of posterior points; female abdominal sternite VIII without internal sclerite (figs. 50, 58).
Bucerocolpocephalum deignani, new species, p. 38.

21. Venter of third femora and posterolateral margins of abdominal sternites IV and V, each with brushes of normal setae (figs. 68, 69) 22
Venter of third femora and abdominal sternites IV and V without brushes (figs. 66, 67) . . . . . **Bucerophagus forcipatus** (Nitzsch), p. 42.

22. Metasternal plate triangular, expanded anteriorly (fig. 70).
Bucerophagus productus (Burmeister), p. 44.
Metasternal plate trapezoidal, expanded anteriorly (fig. 68c).
Bucerophagus africanus Bedford, p. 46.

Genus *Chapinia* Ewing

FIGURES 23–26

Chapinia Ewing, 1927, p. 88. [Genotype: *Chapinia robusta* Ewing, 1927.]
Allomenopon Bedford, 1930, p. 153. [Genotype: *Menopon bucerotis* Kellogg, 1908.]

Head triangular, width 1½ to 2 times that of length. Forehead much narrower anteriorly. Temples expanded. Antennae 4-jointed, third segment constricted at base, and terminal segment capitate without signs of division. Antennary fossa deep, covered above by expansion of lateral margin of head, posterior margin of which bears eye with double cornea. Dorsal-lateral margin of forehead anterior to eye with preocular slit or shallow notch. Gular region with 3–7 setae varying in length on each lateral margin. Pronotum expanded anteriorly with posterior marginal row of long setae. Metanotum expanded posteriorly with posterior marginal row of long setae and two short setae on each lateral margin. Metanotum separated from mesonotum and from pleurites. Thoracic sternal plates as shown in figures 23b, 25b, and 26c. Metasternal plate trapezoidal, expanded anteriorly, with 6–22 setae. Venter of third femora and posterolateral margins of abdominal sternites IV–VI, each with or without brushes of normal setae. Abdominal segments consist of tergites, sternites, and pleurites, the latter without prolongation of posteroventral angles.

Abdominal tergites each with a posterior marginal row of setae, the most laterad being the postspiracular seta. Each lateral margin of abdominal tergites II–VI with or without a short seta between the spiracle and postspiracular seta. Sternites and pleurites each with a posterior marginal row of long setae and with numerous shorter setae. Male terminal abdominal sternites VIII and IX fused with partial division only from sternite VII (figs. 4, 10, 22, 24, 26). Male genitalia as illustrated for each species, with parameres either expanded anteriorly or split posteriorly or both. Female terminal abdominal segments as illustrated for each species, with lateral processes arising from ventral sclerite between vulva and anus, with long stout setae but never strong spines. Females larger than males, usually with more abdominal sternal setae, but general shape and chaetotaxy similar to that of males except for terminal abdominal segments.

Both Ewing (1927) and Bedford (1930) stated that the pterothorax was undivided. As noted by Cope (1941), the sclerotized median button behind the prothorax (fig. 25m) is a vestige of the mesonotum; the supposed mesonotum, the narrow sclerotized band posterior to this button, is a mere extension of the subcoxae. Ewing (1927) stated that the abdomen consisted of 9 segments in the female and 10 segments in the male, but as shown by Cope (1941), the abdomen of both the male and female has 10 segments each.

Chapinia resembles most closely *Bucerophagus* (figs. 66–69) but differs in several characters: The terminal segment of the antenna shows no sign of division in *Chapinia*, but there are definite signs of division into two parts either by transverse line or marginal indentation in *Bucerophagus*. The venter of the third femora may have brushes of normal setae in *Chapinia* and *Bucerophagus*; similar brushes are present on posterolateral margins of abdominal sternites IV–VI in *Chapinia* but abdominal sternites IV and V in *Bucerophagus*. Each lateral margin of abdominal tergites II–VI may have a short seta between the spiracle and postspiracular seta in *Chapinia*, but 1–5 short setae may be present on margins of abdominal tergites II–VIII in *Bucerophagus*. Male terminal abdominal sternites VIII and IX are fused in *Chapinia* with partial division only from abdominal sternite VII, but abdominal sternites VIII and IX may be fused in *Bucerophagus* with a complete division from abdominal sternite VII. Male genitalia have parameres slender or expanded anteriorly in *Chapinia* but branched anteriorly in *Bucerophagus*. Lateral processes arising from the ventral sclerite between the female vulva and anus have long stout setae in *Chapinia* but long stout setae and strong spines in *Bucerophagus*.

The male genitalia and details of the male and female terminal abdominal segments are the best characters for separating species

of *Chapinia*. Other characters useful in species separation are: The presence or absence of brushes of normal setae on the venter of the third femora and posterolateral margins of abdominal sternites IV–VI; the presence or absence of a short seta on each lateral margin of abdominal tergites III–VI between the spiracle and postspiracular seta; the number of median rows of setae, and the total number of setae on abdominal sternite II. The number and length of setae on the lateral margins of the gular region are too variable to be of much use in separating species.

For convenience of classification the species of *Chapinia* have been arranged into species-groups.

Hosts: Species of *Chapinia* have been found on the genera *Tockus*, *Anorrhinus*, *Penelopides*, *Rhyticeros*, *Anthracocerus*, *Bycanistes*, *Ceratogymna*, and *Buceros* of the avian family Bucerotidae.

The *lophocerus* Species-Group

Species similar in shape to *Chapinia robusta* (figs. 23, 24). Differing from other species-groups in the following combination of characters: Dorsal-lateral margins of head with preocular slit; venter of third femora and posterolateral margins of abdominal sternites IV–VI each with brushes of normal setae; each lateral margin of abdominal tergites II–VI with or without a short seta between the spiracle and postspiracular seta; females with more abdominal sternal setae than males; abdominal sternite II with either one or three median rows of setae; male genitalia with lateral horns on each side of endomeres and with parameres enlarged anteriorly, not split posteriorly; females with sclerital hooks on each side of midline of ventral sclerite between vulva and anus; female abdominal sternite VIII with most of setae similar in size to setae on posterior margin.

Hosts: Species of the *lophocerus* species-group have been found on the genera *Tockus*, *Bycanistes*, and *Ceratogymna* of the avian family Bucerotidae.

Species of the *lophocerus* species-group are all similar in size except that both sexes of *Chapinia camuri* are smaller than corresponding sexes of other species, and males of *C. robusta* are larger than other males. The small size of *C. camuri* might be expected since its host, the 15-inch *Tockus camurus*, is the smallest known hornbill. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have large thick brushes of normal setae in *C. bucerotis* but small scattered brushes of normal setae in other species of the *lophocerus* species-group, although the brushes are slightly thicker in *C. robusta*. Each lateral margin of abdominal tergites II–VI has a short seta between the spiracle and postspiracular seta in

all species except in *C. robusta*. Abdominal sternite II has more total setae in both sexes of *C. bucerotis* and *C. robusta* than in corresponding sexes of *C. fasciati*, *C. lophocerus*, and *C. camuri*; this sternite has one median row of setae in all species except *C. bucerotis*, which has three median rows. The male genitalia have each lateral horn possessing posterior points in all species except *C. robusta*, which has one sharp median point crossing the broad endomeres; the posterior points are sharp in *C. bucerotis* and *C. lophocerus* but rounded in *C. fasciati* and *C. camuri*; *C. camuri* has only one posterior point instead of two as in the other species; the two points do not reach the slender endomeres in *C. lophocerus*, but one point crosses the broad endomeres in *C. bucerotis* (figs. 1–7). In the female the ventral sclerite between the vulva and anus is elevated medially between the sclerital hooks in *C. fasciati*, *C. bucerotis*, and *C. robusta*, is elevated only slightly in *C. camuri*, and is not elevated in *C. lophocerus*. The female anal fringe has the most setae in *C. fasciati* and the fewest in *C. lophocerus*.

Clay (1958) treated populations of the ischnoceran genus *Degeeriella* as subspecies when the male genitalia were apparently identical or differed only in a minor degree and when there were other minor morphological differences. Because of similarity of the genitalia, *Chapinia fasciati* and *C. camuri* could be considered subspecies of *C. lophocerus*. This would express the similarity of their six host species, which are all members of the Ethiopian genus *Tockus*. Clay (1958) pointed out that the genitalia, particularly in the Amblycera, might show only minor differences throughout a genus or species-group and great differences in other groups. She therefore concluded that differentiation of the genitalia has taken place at different rates in different groups. Similarly, Johnson (1960) stated that evolution and morphological divergence would not be expected to proceed at the same rate for all free-living species. It would seem that the similarity in the genitalia of *C. fasciati*, *C. lophocerus*, and *C. camuri* would indicate either that evolution has not proceeded as rapidly in these species or that they have not been isolated as long as other species of *Chapinia*. Clay (1958) stated that if subspecies were populations that would interbreed under natural conditions if they occurred sympatrically, any morphological differences which might prevent interbreeding should be considered as specific characters. Johnson (1960) believes that there is little possibility of finding interbreeding populations among lice which are isolated on their hosts. She stated that it would be desirable to treat all stable recognizable forms of Anoplura and Mallophaga as species. Clay (1962) consequently stated that the subspecific category might be useful in some of the ischnoceran genera, but its application in the Amblycera is less satisfactory and

should not be used until more is known about the relationships between populations in this superfamily.

The members of the *lophocerus* species-group are arranged according to the phylogeny of their hosts, since this order agrees with the morphological similarities or the parasites.

Chapinia fasciati, new species

FIGURE 1

Male: Smaller than *Chapinia robusta* in all measurements; smaller than *C. lophocerus* in all measurements except width of metathorax (table 1). Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae. Each lateral margin of abdominal tergites II–VI with a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 32–42 total setae and one median row of setae on posterior margin. Terminal abdominal segments similar to those of *C. lophocerus*. Genitalia as shown in figure 1, each lateral horn with two rounded posterior points.

Female: Larger than *Chapinia robusta* in all measurements except width of metathorax; smaller than *C. lophocerus* in all measurements except total length and width of prothorax (table 2). Resembles the male except that abdominal sternite II has 54 total setae. Terminal abdominal segments similar to those of *C. lophocerus*. Ventral sclerite between vulva and anus elevated medially between sclerital hooks. Anal fringe with 72–86 setae.

Discussion: *Chapinia fasciati* resembles most closely *C. lophocerus*. The male genitalia have each lateral horn possessing two posterior points which are rounded in *C. fasciati* but sharp in *C. lophocerus*. The ventral sclerite between female vulva and anus is elevated medially between the sclerital hooks in *C. fasciati* but not elevated in *C. lophocerus*. The female anal fringe has more than 70 setae in *C. fasciati* but fewer than 58 setae in *C. lophocerus*.

Material examined: 27 males and 34 females from fresh and dried material collected in the Ethiopian region.

Type host: *Tockus fasciatus fasciatus* (Shaw, 1811).

Type material: Holotype male and allotype female from Eden, French Cameroons, Africa, collected by J. Mouchet, BMNH. Paratypes: 18 males and 15 females from French Cameroons, Africa, collected by J. Mouchet, BMNH; 1 male from Kasongo, Belgian Congo, Africa, Nov. 13, 1959, collected by P. L. G. Benuit, JT; 3 males and 10 females from CNHM skins from Entebbe, Uganda, Africa, 1895–1916, collected by F. J. Jackson and others, REE; 2 males and 1 female from CNHM skins from Bitya, Cameroons,

Africa, 1924–1927, collected by O. L. Bates, REE; 1 female from CNHM skin from Yokadouma, French Cameroons, Africa, Oct. 19, 1946, collected by A. I. Good, REE; 1 female from CNHM skins from Bwamba, Ruwenzori, Uganda, Africa, 1944–1946, collected by V. Someren, REE; 1 male from CNHM skins from Ebolowa, French Cameroons, Africa, 1952–1953, collected by A. I. Good, REE; 1 male and 3 females from USNM skins from Congo, Africa, 1917, collected by C. R. Aschemeier, REE; from *Tockus alboterminatus suahelicus* (Neumann, 1905): 1 female from CNHM skins from Sokoke Forest, Kenya, Africa, June 1932, collected by V. Someren, REE; 1 female from USNM skins from Nairobi, Kenya, Africa, 1909, collected by Loring and Mearns, REE.

Chapinia lophocerus (Bedford)

FIGURES 2, 4, 27, 28

Menopon lophocerus Bedford, 1920, p. 717, pls. 1 (fig. 1), 3 (fig. 1). [Type host: *Lophoceros leucomelas*=*Tockus flavirostris leucomelas* (Lichtenstein, 1842).]
Chapinia lophocerus (Bedford)—Hopkins and Clay, 1952, p. 67.

Bedford did not designate a type from his material which contained a pair of Mallophaga from *Lophoceros leucomelas*=*Tockus flavirostris leucomelas* (Lichtenstein, 1842), a pair from *L. epirhinus*=*Tockus nasutus caffer* (Sundevall, 1851), and two males and one female from *L. erythrorhynchos*=*Tockus e. erythrorhynchus* (Temminck, 1823). A lectotype was designated by Hopkins (1941) from the host, *Lophoceros leucomelas*, since the male from that host agreed best with Bedford's figure of the male genitalia.

Male: Smaller than *Chapinia robusta* in all measurements (table 1). Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae. Each lateral margin of abdominal tergites II–VI with a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 28–42 total setae and one median row of setae on posterior margin. Terminal abdominal segments as shown in figure 4. Genitalia as shown in figure 2, each lateral horn with two sharp posterior points which do not reach the slender endomeres.

Female: Larger than *Chapinia robusta* in all measurements except width of prothorax and width of metathorax (table 2). Resembles the male except that abdominal sternite II has 34–54 total setae. Terminal abdominal tergite with 22–30 setae, short setae alternating with long, on posterior margin; ventral sclerite between vulva and anus not elevated medially between sclerital hooks (fig. 27). Anal fringe with 42–56 setae (fig. 28).

Discussion: Bedford (1920) gave the following measurements (in mm).

	male	*female*
length of head	0.25	0.33
width of head	0.53	0.60
width of prothorax	0.38	0.43
width of metathorax	0.55	0.71
width of abdomen	0.85	1.15
total length	1.74	2.36

Except for females being larger in abdominal width and total length, these measurements fall within the ranges of *Chapinia lophocerus* (tables 1, 2). *C. lophocerus* resembles most closely *C. fasciati*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have small scattered brushes of normal setae in *C. lophocerus*, *C. fasciati*, and *C. camuri* but large thick brushes of normal setae in *C. bucerotis*. Abdominal sternite II of both sexes has fewer than 58 total setae and one median row of setae in *C. lophocerus*, *C. fasciati*, and *C. camuri* but more than 58 total setae and three median rows of setae in *C. bucerotis*. The male genitalia have each lateral horn possessing posterior points that do not reach the slender endomeres in *C. lophocerus*, *C. fasciati*, and *C. camuri* but one sharp point that crosses the broad endomeres in *C. bucerotis*; the posterior two points are sharp in *C. lophocerus* but rounded in *C. fasciati*, and there is only one rounded posterior point in *C. camuri*. The ventral sclerite between female vulva and anus is not elevated medially between the sclerital hooks in *C. lophocerus*, is elevated slightly in *C. camuri*, but is more elevated in *C. fasciati* and *C. bucerotis*. The female anal fringe has fewer than 58 setae in *C. lophocerus*, at least 72 setae in *C. fasciati*, and 58–72 setae in *C. camuri* and *C. bucerotis*.

Material examined: 6 males and 19 females from fresh and dried material collected in the Ethiopian region; lectotype male and syntype female from Transvaal, South Africa, September 1917, collected by G. A. H. Bedford, GHEH; from the type host: 1 male and 4 females from Pretoria Zoo, South Africa, Feb. 10, 1938, collected by G. A. H. Bedford, GHEH; from *Tockus n. nasutus* (Linnaeus, 1766): 1 male and 1 female from Maroua, North French Cameroons, Africa, 1959, collected by J. Mouchet, BMNH 1960–105; 1 male and 2 females from Mansôa, Portuguese Guinea, Africa, Feb. 14, 1951, collected by J. Tendeiro, JT; from *Tockus e. erythrorhynchus* (Temminck, 1823): 1 male and 4 females from Somaliland, Africa, February 1949, Meinertzhagen 18708, BMNH; 1 male from USNM skins from Ethiopia, Africa, 1912, collected by Childs Frick, REE; from *Tockus f. flavirostris* (Rüppell, 1835): 1 female from USNM skins from Ethiopia, Africa, 1912, collected by Childs Frick, REE; from *Tockus deckeni* (Cabanis, 1869): 6 females from Koka, Ethiopia, Africa, Dec. 13, 1960, collected by Savo Brelih, PMS.

Drawings were made of the lectotype male and a female collected in the Pretoria Zoo. Specimens in GHEH.

***Chapinia camuri*, new species**

FIGURE 3

Male: Smaller than *Chapinia robusta* in all measurements; smaller than *C. lophocerus* in all measurements except length of head and width of prothorax (table 1). Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae. Each lateral margin of abdominal tergites II–VI with a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 37 or 38 total setae and one median row of setae on posterior margin. Terminal abdominal segments similar to those of *C. lophocerus*. Genitalia as shown in figure 3, each lateral horn with one rounded posterior point.

Female: Smaller than other *Chapinia* in all measurements except length of head and width of abdomen (table 2). Resembles the male except that abdominal sternite II has 44–56 total setae. Terminal abdominal segments similar to those of *C. lophocerus*. Ventral sclerite between vulva and anus slightly elevated medially between sclerital hooks. Anal fringe with 60–64 setae.

Discussion: Although smaller in size, *Chopinia camuri* resembles most closely *C. lophocerus*. The male genitalia have each lateral horn possessing one rounded posterior point in *C. camuri* but two sharp posterior points in *C. lophocerus*. The ventral sclerite between female vulva and anus is elevated medially only slightly between the sclerital hooks in *C. camuri* and is not elevated in *C. lophocerus*. The female anal fringe has more than 58 setae in *C. camuri* but fewer than 58 setae in *C. lophocerus*.

Material examined: 2 males and 2 females from fresh material collected in the Ethiopian region.

Type host: *Tockus camurus camurus* Cassin, 1857.

Type material: Holotype male and allotype female from Ambam, French Cameroons, Africa, 1955, collected by J. Mouchet, BMNH. Paratypes: 1 male and 1 female with same data.

***Chapinia bucerotis* (Kellogg)**

FIGURES 5, 6, 29, 30

Menopon bucerotis Kellogg, 1908, p. 54, pl. 7 (fig. 12).—Bedford, 1920, pl. 3 (fig. 2) (male genitalia). [Type host: *Bycanistes cristatus*=*Bycanistes brevis omissus* Peters, 1945.]

Chapinia bucerotis (Kellogg).—Hopkins and Clay, 1952, p. 67.

Kellogg did not designate a type from his material, which contained 1 male and 1 female syntypes on slides and about 40 syntypes in

alcohol. The slide specimens were remounted and the male is designated hereby as a lectotype; the slide has been so labeled. Approximately one-half of the syntype material formerly in alcohol was mounted.

Male: Smaller than *Chapinia robusta* in all measurements (table 1). Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with large thick brushes of normal setae. Each lateral margin of abdominal tergites II–VI with a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 60–82 setae and three median rows of setae. Terminal abdominal segments as shown in figure 5. Genitalia as shown in figure 6, each lateral horn with two sharp posterior points, one of which crosses the broad endomeres.

Female: Approximately the same size as *Chapinia robusta* (table 2). Resembles the male except that abdominal sternite II has 68–104 total setae. Terminal abdominal tergite with 22–32 setae, short setae alternating with long, on posterior margin; ventral sclerite between vulva and anus elevated medially between sclerital hooks (fig. 29). Anal fringe with 58–72 setae (fig. 30).

Discussion: Kellogg (1908) gave the following measurements (in mm).

	male	*female*
length of head	0.33	0.40
width of head	0.65	0.72
width of abdomen	0.80	1.10
total length	2.00	2.80

These measurements are slightly larger than those given here for *Chapinia bucerotis* (tables 1, 2). *C. bucerotis* resembles most closely *C. lophocerus*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have large thick brushes of normal setae in *C. bucerotis* but small scattered brushes of normal setae in other species of the *lophocerus* species-group. Each lateral margin of abdominal tergites II–VI has a short seta between the spiracle and postspiracular seta in *C. bucerotis* but not in *C. robusta*. Abdominal sternite II of both sexes has more than 58 total setae in *C. bucerotis* but fewer than 58 total setae in *C. lophocerus;* this sternite has three median rows of setae in *C. bucerotis* but one median row of setae on posterior margin in other species of the *lophocerus* species-group. The male genitalia have each lateral horn possessing two sharp posterior points in *C. bucerotis* and *C. lophocerus*, but one point crosses the broad endomeres in *C. bucerotis*, and the points do not reach the slender endomeres in *C. lophocerus;* each lateral horn in *C. robusta* has one sharp median point that crosses the broad endomeres. The ventral sclerite between female vulva and anus is elevated medially between the sclerital hooks in *C. bucerotis* almost

as much as in *C. robusta* but is not elevated in *C. lophocerus*. The female anal fringe has at least 58 setae in *C. bucerotis* but at most 56 setae in *C. lophocerus*.

Material examined: 34 males, 29 females, and approximately 20 specimens in alcohol from fresh and dried material collected in the Ethiopian region; lectotype male and syntypes, 12 males, 13 females, and about 20 syntypes in alcohol from Kilimanjaro, Tanganyika, Africa, collected by Sjöstedt, SMNH; from *Bycanistes bucinator sharpii* (Elliot, 1873): 1 female from CNHM skin from Mount Tandan, Mouila, Gabon, Africa, June 9, 1951, collected by H. A. Beatty, REE; 1 female from USNM skins from Congo, Africa, 1917–1918, collected by C. R. Aschemeier, REE; from *Bycanistes bucinator duboisi x sharpii:* 1 female from CNHM skin from Yaounde, French Cameroons, Africa, July 12, 1948, collected by A. I. Good, REE; from *Bycanistes bucinator duboisi* W. Sclater, 1884: 1 male from CNHM skins from Elat, French Cameroons, Africa, collected by Rev. M. Fraser, REE; from *Bycanistes b. bucinator* (Temminck, 1824): 1 male and 1 female from Pietermaritzburg, South Africa, 1917, GHEH; 3 males and 2 females from CNHM skins from Kenya, Africa, 1918–1922, collected by V. Someren, REE; from *Bycanistes c. cylindricus* (Temminck, 1831): 1 male and 1 female from CNHM skins from Liberia, Africa, February–June 1948, collected by H. A. Beatty, REE; from *Bycanistes cylindricus albotibialis* (Cabanis and Reichenow, 1877): 2 males and 1 female from Mbalmayo, French Cameroons, Africa, collected by J. Mouchet, BMNH; 1 male from CNHM skin from French Cameroons, Africa, July 8, 1907, REE; 1 male from CNHM skin from French Cameroons, Africa, June 25, 1940, collected by A. I. Good, REE; 1 male from CNHM skin from Uganda, Africa, July 15, 1945, collected by V. Someren, REE; from *Bycanistes subcylindricus subquadratus* Cabanis, 1880: 6 males and 6 females from Uganda, Africa, April 1936, Meinertzhagen 7674, 7708, 7709, BMNH; 1 male from CNHM skin from Kampala, Uganda, Africa, Sept. 2, 1918, collected by V. Someren, REE; 1 male and 2 females from USNM skins from Uganda, Africa, June 1920, collected by H. C. Raven, REE; from *Bycanistes b. brevis* Friedmann, 1929: 2 males from CNHM skin from Mount Kenya, Kenya, Africa, November 1946, collected by V. Someren, REE.

Drawings were made of the lectotype male and the syntype female mounted on the same slide. Specimens in SMNH.

Chapinia robusta Ewing

FIGURES 7, 23, 24, 31, 32

Chapinia robusta Ewing, 1927, p. 89. [Type host: *Ceratogymna atrata* (Temminck, 1835).]

Chapinia robusta Ewing,—Hopkins and Clay, 1952, p. 68.

Through the courtesy of Dr. K. C. Emerson, BMNH specimens from the type host, here examined, were determined to be conspecific with the USNM holotype and allotype (USNM 40137, Nytonga, Congo, Africa, Nov. 3, 1917, collected by E. A. Chapin).

Male: As illustrated in figure 24. Larger than other species of the *lophocerus* species-group in all measurements except width of abdomen; approximately the same size as *Chapinia traylori* (table 1). Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae. Each lateral margin of abdominal tergites II–VI without a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 48–66 total setae and one median row of setae on posterior margin. Terminal abdominal segments as shown in figure 24c. Genitalia as shown in figure 7, each lateral horn with one large sharp point which crosses the broad endomeres.

Female: As illustrated in figure 23. Larger than *Chapinia camuri* in all measurements except length of head; approximately the same size as other species of the *lophocerus* species-group; slightly smaller than *C. traylori* in all measurements except length of head (table 2). Resembles the male except that abdominal sternite II has 56–68 total setae. Terminal abdominal tergite with 20–24 setae, short setae alternating with long, on posterior margin; ventral sclerite between vulva and anus elevated medially between sclerital hooks (fig. 31). Anal fringe with 56–62 setae (fig. 32).

Discussion: Ewing (1927) gave the following measurements (in mm).

	male	*female*
width of abdomen	0.70	0.95
total length	1.59	2.00

These measurements are not as great as those given here for *Chapinia robusta* (tables 1, 2). *C. robusta* resembles most closely *C. bucerotis*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have small scattered brushes of normal setae in *C. robusta*, slightly more numerous than for other species of the *lophocerus* species-group, except *C. bucerotis*, which has large thick brushes of normal setae. Each lateral margin of abdominal tergites II–VI in *C. robusta* lacks the short seta between the spiracle and postspiracular seta that is present in all other species of the *lophocerus* species-group. Abdominal sternite II has one median row of setae in *C. robusta* but three median rows of setae in *C. bucerotis*. Male genitalia have each lateral horn possessing one sharp median point that crosses the broad endomeres in *C. robusta* but two sharp posterior points, one of which crosses the broad endomeres, in *C. bucerotis*. The ventral sclerite between female vulva and anus is elevated

medially between the sclerital hooks slightly more in *C. robusta* than in *C. bucerotis*.

Material examined: 4 males and 5 females from fresh and dried material collected in the Ethiopian region; from the type host: 3 males and 3 females from Ambam, French Cameroons, Africa, 1955, collected by J. Mouchet, BMNH; 1 female from CNHM skin from Fougamou, Gabon, Africa, Aug. 4, 1951, collected by H. A. Beatty, REE; from *Ceratogymna elata* (Temminck, 1831): 1 male and 1 female from Konn, French Cameroons, Africa, Apr. 26, 1947, collected by V. Aellen, BMNH 1954–487.

Drawings were made of a male and a female from the type host collected in Ambam, French Cameroons, Africa. Specimens in BMNH.

The *acutovulvata* Species-Group

Species similar in shape to *Chapinia traylori* (figs. 25, 26). Differing from other species-groups in the following combination of characters: Dorsal-lateral margins of head with a preocular notch; venter of third femora and posterolateral margins of abdominal sternites IV–VI each with or without brushes of normal setae; each lateral margin of abdominal tergites II–VI with or without a short seta between the spiracle and postspiracular seta; females usually with more abdominal sternal setae than males; abdominal sternite II usually with one median row of setae on posterior margin; male genitalia without lateral horns on each side of endomeres and with parameres enlarged anteriorly, split posteriorly; females without sclerital hooks on each side of midline of ventral sclerite between vulva and anus; female abdominal sternite VIII with most of setae much shorter than those on the posterior margin.

Hosts: Species of the *acutovulvata* species-group have been found on the genera *Tockus*, *Anorrhinus*, *Penelopides*, *Rhyticeros*, *Anthracoceros*, and *Buceros* of the avian family Bucerotidae.

Species of the *acutovulvata* species-group are all similar in size except that males of *Chapinia wenzeli* are smaller than other males, and females of *C. traylori* are larger than other females. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have large thick brushes of normal setae in both sexes of *C. waniti*, *C. acutovulvata*, *C. malayensis*, and *C. hoplai*; small scattered brushes of normal setae in females of *C. blakei* and in both sexes of *C. clayae*, *C. boonsongi*, *C. wenzeli*, and *C. lydae*; brushes are absent in the male of *C. blakei* and in both sexes of *C. traylori*. Each lateral margin of abdominal tergites II–VI has a short seta between the spiracle and postspiracular seta in *C. clayae*, *C. waniti*, *C. acutovulvata*,

and *C. malayensis*. Abdominal sternite II has more total setae in both sexes of *C. waniti*, *C. acutovulvata*, and *C. hoplai* than in corresponding sexes of *C. malayensis*, *C. wenzeli*, *C. blakei*, and *C. traylori*; more total setae in females than in males except in *C. lydae;* and setae are arranged in one median row except for one or two median rows in *C. waniti*, two median rows in *C. traylori*, and three median rows in *C. lydae*. The male genitalia have endomeres with an inner plate and paired outer rims in *C. clayae*, *C. waniti*, *C. acutovulvata*, *C. malayensis*, and *C. lydae*, the paired outer rims possessing internal knobs only in *C. clayae* and *C. acutovulvata* and serrulations only in *C. waniti;* the inner plate possessing paired lateral flanges and central terminal point only in *C. malayensis;* only paired outer rims in *C. hoplai*, *C. boonsongi*, and *C. wenzeli*, the posterolateral margin being split in *C. wenzeli;* and only paired plates in *C. blakei* and *C. traylori*. The female terminal abdominal tergite has on the posterior margin at most 24 setae except for *C. waniti*, *C. acutovulvata*, and *C. hoplai* with at least 24 setae; of these setae approximately two-thirds are long and one-third are short in *C. waniti*, *C. acutovulvata*, *C. malayensis*, *C. boonsongi*, and *C. lydae;* approximately one-half are long and one-half are short in *C. clayae*, and *C. hoplai;* these setae are arranged with at least five long setae on each side of the midline in *C. acutovulvata* and *C. malayensis* but at most six setae in all other species of the *acutovulvata* species-group. In the female the ventral sclerite between the vulva and anus is curved sharply on the anterior margin in *C. clayae* and *C. acutovulvata* but is only slightly curved in the other species of the group; on each lateral projection of this sclerite there are 4–6 thick, posteriorly directed setae except in *C. waniti* which has 10 or 11 and in *C. traylori* which has 2 or 3 (figs. 43 sp, 44 sp, and 72 sp). The female abdominal sternite VIII has on the posterior margin the most setae in *C. malayensis* with more than 34 and the fewest in *C. blakei* with at most 18. The female anal fringe has at least 44 setae in *C. waniti*, *C. acutovulvata*, *C. malayensis*, *C. hoplai*, *C. boonsongi*, and *C. lydae* but at most 44 setae in *C. clayae*, *C. wenzeli*, *C. blakei*, and *C. traylori*.

Were the species of the *acutovulvata* species-group arranged according to the phylogeny of their hosts (Peters, 1945), the order would be: *C. clayae*, *C. waniti*, *C. wenzeli*, *C. blakei*, *C. lydae*, *C. boonsongi*, *C. malayensis*, *C. acutovulvata*, *C. hoplai*, and *C. traylori*, rather than *C. clayae*, *C. waniti*, *C. acutovulvata*, *C. malayensis*, *C. hoplai*, *C. boonsongi*, *C. wenzeli*, *C. blakei*, *C. traylori*, and *C. lydae*, which is based on morphological similarities of the lice.

***Chapinia clayae*, new species**

FIGURES 8, 33, 34

Both sexes are smaller than corresponding sexes of *Chapinia traylori* in all measurements except length of head (tables 1, 2).

Male: Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae. Each lateral margin of abdominal tergites II–VI with a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 38–50 total setae and one median row of setae on posterior margin. Terminal abdominal segments similar to those of *C. acutovulvata*. Genitalia as shown in figure 8, endomeres with small inner plate and paired outer rims.

Female: Resembles the male except that abdominal sternite II has 66–76 total setae. Terminal abdominal tergite with 12 long and 12 short setae on posterior margin; abdominal sternite VIII with 22–30 setae on posterior margin (fig. 33). Anal fringe with 38–44 setae (fig. 34).

Discussion: Although smaller in size, *Chapinia clayae* resembles most closely *C. acutovulvata*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have small scattered brushes of normal setae in *C. clayae* but large thick brushes of normal setae in *C. acutovulvata*. The male genitalia have endomeres possessing on each outer rim a triangular internal knob that is wider than long in *C. clayae* but longer than wide in *C. acutovulvata*. The female terminal abdominal tergite has on the posterior margin at most 24 setae, of which approximately one-half are long and one-half are short, in *C. clayae*, but at least 26 setae, of which approximately two-thirds are long and one-third are short, in *C. acutovulvata*. In addition this margin has on each side of the midline at most four long setae in *C. clayae* but at least six long setae in *C. acutovulvata*. The female anal fringe has at most 44 setae in *C. clayae* but at least 44 setae in *C. acutovulvata*.

Material examined: 19 males and 29 females from fresh and dried material collected in India and Nepal.

Type host: *Tockus birostris* (Scopoli, 1786).

Type material: Holotype male, allotype female, and 2 male and 4 female paratypes on same slide from Rajputana, India, March 1937, Meinertzhagen 8855–8856, BMNH. The holotype and allotype are each the second from the right in the rows of males and females as seen under the microscope. Paratypes: 5 males and 12 females with same data except Meinertzhagen 8932; 1 male from Nepal,

December 1935, Meinertzhagen 4859, BMNH; 4 males and 5 females from Nepal, February 1936, Meinertzhagen 4858, BMNH; 1 female from CNHM skins from Kotla, Kangra, East Punjab, India, 1946 and 1948, collected by W. Koelz, REE; 1 male and 1 female from CNHM skins from Bheraghat, Central Provinces, India, March–April 1946, collected by W. Koelz and R. Chand, REE; 1 male from CNHM skins from Belwani, Kisli, Central Provinces, India, July–August 1946, collected by W. Koelz, REE; 1 female from CNHM skin from Kanha, Central Provinces, India, Aug. 29, 1946, collected by R. Chand, REE; 2 males from CNHM skins from Kalnali, United Provinces, India, February 1947, collected by W. Koelz, REE; 1 male and 1 female from CNHM skins from Nichland, United Provinces, India, February 1947, collected by W. Koelz, REE; 1 female from CNHM skins from Simra, Nepal, Mar. 4, 1947, collected by W. Koelz and R. Chand, REE; 1 female from CNHM skins from Baihar, Balaghat, India, January–February 1949, collected by R. L. Flemming, REE; 1 female from USNM skins from India, 1898, 1946–1948, REE; from *Tockus g. griseus* (Latham, 1790): 1 male from CNHM skins from Nilambus, Madras, India, February–March 1937, collected by W. Koelz, REE.

Chapinia clayae is named for Dr. Theresa Clay of the British Museum (Natural History) in appreciation for her continuous assistance throughout the study, for the loan of hornbill Menoponidae from the BMNH, and for helping to obtain the loan of hornbill Menoponidae from other museums.

Chapinia waniti, new species

FIGURES 71, 72

Male: Larger than *Chapinia traylori* in all measurements except width of prothorax and width of metathorax (table 1). Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with large thick brushes of normal setae. Each lateral margin of abdominal tergites II–VI with a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 68–78 total setae and one or two median rows of setae. Terminal abdominal segments similar to those of *C. acutovulvata*. Genitalia as shown in figure 71, endomeres with small inner plate and paired outer rims.

Female: Smaller than *Chapinia traylori* in all measurements except length and width of head (table 2). Resembles the male except that abdominal sternite II has 92–104 total setae. Terminal abdominal tergite with 14–18 long and 10–12 short setae on posterior margin; abdominal sternite VIII with 28–34 setae on posterior margin (fig. 72); each lateral projection of the ventral sclerite between vulva and anus

with 10–11 thick, posteriorly directed setae (fig. 72 sp). Anal fringe similar to that of *C. acutovulvata*, with 56–64 setae.

Discussion: *Chapinia waniti* resembles most closely *C. acutovulvata*. Abdominal sternite II of both sexes has more total setae in *C. waniti* than in corresponding sexes of *C. acutovulvata*. The male genitalia have endomeres possessing on each outer rim serrulations on the posterior inner margin in *C. waniti* but a triangular internal knob in *C. acutovulvata*. Each lateral projection of the ventral sclerite between female vulva and anus has more than eight thick, posteriorly directed setae in *C. waniti* but fewer than eight in all other *Chapinia*. The female anal fringe has at least 56 setae in *C. waniti* but at most 54 setae in *C. acutovulvata*.

Material examined: 8 males and 7 females from fresh material collected in Thailand.

Type host: *Anorrhinus galeritus carinatus* (Blyth, 1845).

Type material: Holotype male and allotype female from Chong, Muang, Trang, Thailand, Mar. 4, 1963, collected by Wichit Suwan Laong, USNM. Paratypes: 6 males and 3 females with same data; 1 male and 1 female from Lamo, Muang, Trang, Thailand, Mar. 3, 1963, collected by Wichit Suwan Laong, USNM; 2 females from Na Wong, Muang, Phatthalung, Thailand, Mar. 6, 1963, collected by Wichit Suwan Laong, USNM.

Chapinia waniti is named for Mr. Wanit Songprakob, Songkhla, Thailand, in appreciation for mounting Mallophaga and for directing the activities of the field collector, Wichit Suwan Laong. After my departure from Thailand in April 1963, both boys collected for the Bernice P. Bishop Museum.

Chapinia acutovulvata (Piaget)

FIGURES 9, 10, 35, 36

Menopon acutovulvatum Piaget, 1881, p. 5, pl. 1 (fig. 4). [Type host: *Buceros malabaricus*=*Anthracoceros a. albirostris* (Shaw, 1808).]

Menopon acutovulvatum Piaget, 1885, p. 106, pl. 11 (fig. 8).

Allomenopon mjöbergi Eichler, 1947, pp. 2, 20, figs. 1, 2 (new synonym). [Type host: *Anthracoceros convexus* (Temminck, 1831).]

Chapinia mjöbergi (Eichler)—Hopkins and Clay, 1952, p. 68.

Chapinia acutovulvata (Piaget)—Hopkins and Clay, 1952, p. 67.

Dr. Eichler's specimens of *Chapinia mjöbergi* from *Anthracoceros convexus* in the Zoological Museum, Humboldt University, Berlin, were loaned through the courtesy of Dr. von Kēler. Comparison of these lice with specimens of *Chapinia acutovulvata* from the type host discloses no morphological differences between the two series.

A lectotype male for *Chapinia acutovulvata* was designated by Clay (1949a) from the Piaget collection, now in BMNH, BM 777, with 6 syntype females, BM 774 and 776.

Both sexes are smaller than corresponding sexes of *Chapinia traylori* in all measurements except length and width of head (tables 1, 2).

Male: Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with large thick brushes of normal seta. Each lateral margin of abdominal tergites II–VI with a short setae between the spiracle and postspiracular seta. Abdominal sternite II with 42–54 total setae and one median row of setae on posterior margin. Terminal abdominal segments as shown in figure 10. Genitalia as shown in figure 9, endomeres with small inner plate and paired outer rims.

Female: Resembles the male except that abdominal sternite II has 76–86 total setae. Terminal abdominal tergite with 16–22 long and 10–12 short setae on posterior margin; abdominal sternite VIII with 18–30 setae on posterior margin (fig. 35). Anal fringe with 44–54 setae (fig. 36).

Discussion: Although larger in size, *Chapinia acutovulvata* resembles most closely *C. clayae*. The venter of the third femora and posterolateral margins of abdominal sternites IV-VI each have large thick brushes of normal setae in *C. acutovulvata* but small scattered brushes of normal setae in *C. clayae*. Abdominal sternite II of both sexes of *C. acutovulvata* has fewer total setae than in corresponding sexes of *C. waniti* but has more total setae than in corresponding sexes of *C. malayensis*. The male genitalia have endomeres possessing on each outer rim a triangular internal knob that is longer than wide in *C. acutovulvata* but wider than long in *C. clayae*. These internal knobs are absent in other *Chapinia*. The female terminal abdominal tergite has on the posterior margin at least 26 setae in *C. acutovulvata*, of which approximately two-thirds are long and one-third are short, but at most 24 setae in *C. clayae* and *C. malayensis*, of which approximately one-half are long and one-half are short in *C. clayae*, but approximately two-thirds are long and one-third are short in *C. malayensis*. In addition this margin has on each side of midline at least six long setae in *C. acutovulvata* but at most five long setae in *C. clayae*. The female abdominal sternite VIII has on the posterior margin fewer than 32 setae in *C. acutovulvata* but more than 34 setae in *C. malayensis*. Each lateral projection of the ventral sclerite between female vulva and anus has fewer than eight thick, posteriorly directed setae in *C. acutovulvata*, but more than eight in *C. waniti* (fig. 72 sp.). The female anal fringe has 44–54 setae in *C. acutovulvata*, at most 44 setae in *C. clayae*, and at least 56 setae in *C. waniti*.

Material examined: 33 males and 35 females from fresh and dried material collected in the Oriental region; from the type host: 2 females, Piaget, BMNH 1953–21; 2 males and 2 females from Nepal,

December 1935, Meinertzhagen 4872, BMNH; from *Anthracoceros albirostris leucogaster* (Blyth, 1841): 2 males and 2 females from Myitkyina, Burma, Mar. 26, 1945, collected by the U.S. Typhus Commission, BMNH; 3 males, 1 female with same data, USNM; 2 males and 1 female from Stillwell Road, Myitkyina, Burma, Sept. 26, 1945, collected by H. S. Fuller, BMNH 1947–321 (164); 2 males, 2 females with same data, USNM; 2 males from Hin Laem, Tha Khanun, Kanchanaburi, Thailand, Nov. 27, 1952, collected by Robert E. Elbel and H. G. Deignan, USNM; 2 males from Ban Khlua Klang, Prachuap Khiri Khan, Thailand, December 1952, collected by Robert E. Elbel and H. G. Deignan, USNM; 2 males and 1 female from Ban Nam Phu, Phu Khieo, Chaiyaphum, Thailand, Dec. 22, 1952, collected by Robert E. Elbel, USNM; 1 male and 1 female from Ban Thung Chuak, Salok Bat, Khanu, Kamphaeng Phet, Thailand, June 25, 1953, collected by Robert E. Elbel, USNM; 1 female from Tha Din Daeng, Pa Bon, Pak Pha Yun, Phatthalung, Thailand, July 30, 1962, collected by Wichit Suwan Laong, USNM; 6 males and 6 females from Muang Kluang, Kapoe, Ranong, Thailand, 1962–1963, collected by Wichit Suwan Laong, USNM; 6 males and 11 females from Pa Dong Lan, Chumphae, Khon Kaen, Thailand, Dec. 2, 1962, collected by Kitti Thonglongya, SMRL; from *Anthracoceros coronatus* (Boddaert, 1783): 2 females from CNHM skins from Kanha, Central Provinces, India, August 1946, collected by Rup Chand, REE; 2 females from CNHM skins from Nawadeh, Bihas, India, Nov. 11, 1947, collected by W. Koelz, REE; 1 male from USNM skins from India and Ceylon, 1874 and 1944, collected by B. H. Swales and S. D. Ripley, REE; from *Anthracoceros convexus* (Temminck, 1831): 1 male and 1 female from lot 1584 (TMRN), Zoological Museum, Humboldt University, Berlin; according to Eichler (1947) the Mallophaga WEC 2268 from this later named host were collected in Sumatra by E. Mjöberg; from *Anthracoceros marchei* Oustalet, 1885: 1 male from Puerto Princesa, Palawan, Philippines, May 12, 1962, collected by Max Thompson, USNM BPM–PI 2313.

Drawings were made of a male and a female from *Anthracoceros albirostris leucogaster* collected in Myitkyina, Burma. Specimens in BMNH.

Chapinia malayensis, new species

FIGURES 12, 37

Male: Smaller than *Chapinia traylori* in all measurements except width of abdomen (table 1). Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with large thick brushes of normal setae which are not as numerous on abdominal sternite VI. Each lateral margin of abdominal tergites II–VI with a short seta between the spiracle and postspiracular seta. Abdominal

sternite II with 34 total setae and one median row of setae on posterior margin. Terminal abdominal segments similar to those of *C. acutovulvata*. Genitalia as shown in figure 12, endomeres with large inner plate and paired outer rims.

Female: Slightly smaller than *Chapinia traylori* in all measurements except length of head (table 2). Resembles the male except that abdominal sternite II has 64 total setae. Terminal abdominal tergite with 20 long and 4 short setae on posterior margin; abdominal sternite VIII with 24 long and 12 short setae on posterior margin (fig. 37). Anal fringe similar to that of *C. acutovulvata* with 50 setae.

Discussion: *Chapinia malayensis* resembles most closely *C. acutovulvata*. Abdominal sternite II of both sexes has fewer total setae in *C. malayensis* than in corresponding sexes of *C. acutovulvata*. Male genitalia have endomeres possessing a large inner plate with paired lateral flanges and a central terminal point in *C. malayensis* but a small inner plate in *C. acutovulvata*. The female terminal abdominal tergite has on the posterior margin at most 24 setae in *C. malayensis* but at least 26 setae in *C. acutovulvata*. The female abdominal sternite VIII has on the posterior margin more than 34 setae in *C. malayensis* but fewer than 32 setae in *C. acutovulvata*.

Material examined: 1 male and 1 female from fresh material collected in Borneo.

Type host: *Anthracoceros malayanus* (Raffles, 1822).

Type material: Holotype male and allotype female from Borneo, Meinertzhagen 10910, BMNH.

Chapinia hoplai, new species

FIGURES 13, 38

Both sexes are slightly smaller than corresponding sexes of *Chapinia traylori* in all measurements except length of head (tables 1, 2).

Male: Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with large thick brushes of normal setae. Each lateral margin of abdominal tergites II–VI without a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 66–68 total setae and one median row of setae on posterior margin. Terminal abdominal segments similar to those of *C. acutovulvata*. Genitalia as shown in figure 13, endomeres with paired outer rims only.

Female: Resembles the male except that abdominal sternite II has 80–88 total setae. Terminal abdominal tergite with 14 long and 12 short setae on posterior margin; abdominal sternite VIII with 16 long and 4 short setae on posterior margin (fig. 38). Anal fringe similar to that of *C. acutovulvata* with 50–54 setae.

Discussion: Although slightly larger in size, *Chapinia hoplai* re-

sembles most closely *C. boonsongi*. The venter of the third femora and posterolateral margins of abdominal sternite IV–VI each have large thick brushes of normal setae in *C. hoplai* but small scattered brushes of normal setae in *C. boonsongi*. Abdominal sternite II of both sexes has more total setae in *C. hoplai* than in corresponding sexes of *C. boonsongi*. The male genitalia have endomeres with paired outer rims that are curved inwardly in *C. hoplai* but straight and nearly parallel in *C. boonsongi*. The female terminal abdominal tergite has on the posterior margin more than 24 setae of which approximately one-half are long and one-half are short in *C. hoplai* but fewer than 22 setae of which approximately two-thirds are long and one-third are short in *C. boonsongi*.

Material examined: 3 males and 2 females from dried material collected in the Philippines.

Type host: *Anthracoceros montani* (Oustalet, 1880).

Type material: Holotype male and allotype female from USNM skins from Sulu, and Tawitawi, Philippines, 1891, collected by D. C. Worchester and F. S. Bourns, REE in USNM. Paratypes: 2 males and 1 female with same data.

Chapinia hoplai is named for Dr. Cluff E. Hopla, Department of Zoology, University of Oklahoma, in appreciation for his thoughtful advice while directing this study.

Chapinia boonsongi, new species

FIGURES 11, 14, 39

Both sexes are smaller than corresponding sexes of *Chapinia traylori* in all measurements except length of head (tables 1, 2).

Male: Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae which are not as numerous on abdominal sternite VI. Each lateral margin of abdominal tergites II–VI without a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 48–62 total setae and one median row of setae on posterior margin. Terminal abdominal segments as shown in figure 11. Genitalia as shown in figure 14, endomeres with paired outer rims only.

Female: Resembles the male except that abdominal sternite II has 62–70 total setae. Terminal abdominal tergite with 14–16 long and 4 short setae on posterior margin; abdominal sternite VIII with 18–20 setae on posterior margin (fig. 39). Anal fringe similar to that of *C. acutovulvata* with 50–56 setae.

Discussion: Although slightly smaller in size, *Chapinia boonsongi* resembles most closely *C. hoplai*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have

small scattered brushes of normal setae in *C. boonsongi* but large thick brushes of normal setae in *C. hoplai*. Abdominal sternite II of both sexes has fewer total setae in *C. boonsongi* than in corresponding sexes of *C. hoplai*. The male genitalia have endomeres with paired outer rims that are straight and nearly parallel in *C. boonsongi* but curved inwardly in *C. hoplai*. The female terminal abdominal tergite has on the posterior margin fewer than 22 setae of which approximately two-thirds are long and one-third are short in *C. boonsongi* but more than 24 setae of which approximately one-half are long and one-half are short in *C. hoplai*.

Material examined: 5 males and 8 females from fresh and dried material collected in Thailand.

Type host: *Rhyticeros undulatus ticehursti* Deignan, 1941.

Type material: Holotype male from USNM skin from Ban Hai Huai, Thailand, June 15, 1936, collected by H. G. Deignan, REE in USNM. Additional types from *Rhyticeros u. undulatus* (Shaw, 1811): Allotype female from Khao Phap Pha Mt., Ban Na, Muang, Phatthalung, Thailand, Feb. 7, 1955, collected by Boonsong Lekagul, USNM. Paratypes: 3 males and 3 females with same data; 1 male from BL skin from Nong Ko, Siracha, Chon Buri, Thailand, August 1953, collected by Boonsong Lekagul, REE; 4 females from Lamo, Muang, Trang, Thailand, Mar. 5, 1963, collected by Wichit Suwan Laong, USNM.

Chapinia boonsongi is named for Dr. Boonsong Lekagul, Bangkok physician and naturalist, in appreciation for the fresh material he collected from Thailand and for permission to examine his hornbill skins for Mallophaga.

Chapinia wenzeli, new species

FIGURES 15, 40, 41

Both sexes are smaller than corresponding sexes of *Chapinia traylori* in all measurements except length of head in females (tables 1, 2).

Male: Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae which are not as numerous on abdominal sternite VI. Each lateral margin of abdominal tergites II–VI without a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 30–36 total setae and one median row of setae on posterior margin. Terminal abdominal segments similar to those of *C. boonsongi*. Genitalia as shown in figure 15, endomeres with paired outer rims only, the posterolateral margins of which are split.

Female: Resembles the male except that abdominal sternite II has 50–60 total setae. Terminal abdominal tergite with 12–14 long and 6–8 short setae on posterior margin; abdominal sternite VIII

with 18–24 setae on posterior margin (fig. 40). Anal fringe with 40–44 setae (fig. 41).

Discussion: *Chapinia wenzeli* resembles most closely *C. blakei*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have small scattered brushes of normal setae in both sexes of *C. wenzeli* but only in the female of *C. blakei*. The male genitalia have endomeres with paired outer rims in *C. wenzeli* but paired plates in *C. blakei*. However, the paired plates may be split in *C. blakei*, giving the appearance of paired outer rims and inner plate, but the inner plate in this case is unsymmetrical. The female abdominal sternite VIII has on the posterior margin at least 18 setae in *C. wenzeli* but at most 18 setae in *C. blakei*, and the internal sclerite, absent in *C. wenzeli*, is present in *C. blakei*. The female anal fringe has at least 40 setae in *C. wenzeli* and at most 40 setae in *C. blakei*.

Material examined: 20 males and 23 females from fresh and dried material collected in the Philippines.

Type host: *Penelopides panini samarensis* Steere, 1890.

Type material: Holotype male and allotype female from CNHM skins from Sandayong, Sierra Bullones, Bohol Island, Philippines, April 1955, collected by D. S. Rabor, REE in CNHM. Paratypes: 2 females with same data; 2 males from CNHM skins from Matuguinao, Samar Island, Philippines, April 1957, collected by D. S. Rabor, REE; from *Penelopides panini manilloe* (Boddaert, 1783): 1 male and 1 female from CNHM skin from Bataan, Luzon Island, Philippines, Jan. 17, 1905, collected by Celestino and Canton, REE; from *Penelopides panini mindorensis* Steere, 1890: 1 male from CNHM skin from Balete, Rio Baca, Mindanao, Philippines, Apr. 1, 1905, collected by McGregor, Celestino, and Canton, REE; from *Penelopides panini affinis* Tweeddale, 1877: 8 males and 2 females from CNHM skins from Mindanao, Philippines, 1946 and 1947, collected by Werner and Alcasid, REE; 3 males and 8 females from Davao, Mindanao, Philippines, Jan. 18, 1947, KCE; 4 males and 9 females from Mindanao, Philippines.

Chapinia wenzeli is named for Dr. Rupert L. Wenzel, Curator of Insects, Chicago Natural History Museum, in appreciation for the loan of hornbill Menoponidae from that museum.

Chapinia blakei, new species

FIGURES 16, 42, 43

Male: Slightly smaller than *Chapinia traylori* in all measurements except length of head and width of metathorax (table 1). Venter of third femora and abdominal sternites IV–VI each without brushes. Each lateral margin of abdominal tergites II–VI without a short

seta between the spiracle and postspiracular seta. Abdominal sternite II with 32–42 total setae and one median row of setae on posterior margin. Terminal abdominal segments similar to those of *C. boonsongi*. Genitalia as shown in figure 16, endomeres with paired plates.

Female: Smaller than *Chapinia traylori* in all measurements except length of head (table 2). Resembles the male except that the venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have small scattered brushes of normal setae which are not as numerous on abdominal sternite VI. Abdominal sternite II with 52–64 total setae. Terminal abdominal tergite with 10–16 long and 8–14 short setae on posterior margin; abdominal sternite VIII with 14–18 setae on posterior margin (fig. 43) and with internal sclerite having slender posteriorly divergent margins. Anal fringe with 34–40 setae (fig. 42).

Discussion: *Chapinia blakei* resembles most closely *C. wenzeli*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI each have small scattered brushes of normal setae in females of *C. blakei* and in both sexes of *C. wenzeli*. The male genitalia have endomeres with paired plates in *C. blakei* but paired outer rims in *C. wenzeli*. However, the paired plates may be split in *C. blakei*, giving the appearance of paired outer rims and inner plate, but the inner plate in this case is unsymmetrical. The male genitalia of *C. traylori* also have endomeres with paired plates, but the posterior extension of the endomeres is split in *C. traylori* and not split in *C. blakei*. The female abdominal sternite VIII has on the posterior margin at most 18 setae in *C. blakei* but at least 18 setae in *C. wenzeli*, and the internal sclerite with slender posteriorly divergent margins, present in *C. blakei*, is absent in both *C. wenzeli* and *C. traylori*. The female anal fringe has at most 40 setae in *C. blakei* and at least 40 setae in *C. wenzeli*.

Material examined: 13 males and 16 females from fresh and dried material collected in the Philippines.

Type host: *Rhyticeros l. leucocephalus* (Vieillot, 1816).

Type material: Holotype male and allotype female from CNHM skins from Zamboanga, Mindanao Island, Philippines, 1948 and 1956, collected by D. S. Rabor, REE in CNHM. Paratypes: 11 males and 12 females from Mutya, Canon, Mindanao Island, Philippines, December 1961, collected by Rabor and Gonzales, BPBM; 1 female from Davao, Tagum, Mindanao Island, Philippines, Oct. 13, 1946, collected by H. Hoogstraal, CNHM; from *Rhyticeros leucocephalus waldeni* (Sharpe, 1877): 1 male and 2 females from CNHM skins from Tolong, Negros Island, Philippines, November–December 1948, collected by D. S. Rabor, REE.

Chapinia blakei is named for Dr. Emmet R. Blake, Curator of Birds, Chicago Natural History Museum, in appreciation for permission to examine hornbill skins for Mallophaga in that museum.

Chapinia traylori, new species

FIGURES 17, 25, 26, 44, 45

Male: As illustrated in figure 26. Slightly larger than *Chapinia clayae*, *C. acutovulvata*, *C. malayensis*, *C. hoplai*, *C. boonsongi*, *C. wenzeli*, *C. blakei*, and *C. lydae* in all measurements except length of head in *C. clayae*, *C. acutovulvata*, *C. hoplai*, *C. boonsongi*, *C. blakei*, and *C. lydae*, width of head in *C. acutovulvata*, width of metathorax in *C. blakei*, and width of abdomen in *C. malayensis*; smaller than *C. waniti* in all measurements except width of prothorax and width of metathorax; approximately the same size as *C. robusta* (table 1). Venter of third femora and abdominal sternites IV–VI each without brushes. Each lateral margin of abdominal tergites II–VI without a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 24–42 total setae and two median rows of setae although the anterior row has widely separated setae. Terminal abdominal segments as shown in figure 26e. Genitalia as shown in figure 17, endomeres with paired plates.

Female: As illustrated in figure 25. Larger than *Chapinia waniti* and *Chapinia acutovulvata* in all measurements except length and width of head; slightly larger than other *Chapinia* in all measurements except length of head (table 2). Resembles the male except that abdominal sternite II has 38–58 total setae. Terminal abdominal tergite with 10 long and 6–10 short setae on posterior margin; abdominal sternite VIII with 14–20 setae on posterior margin and with small triangular internal sclerite (fig. 44); each lateral projection of the ventral sclerite between vulva and anus with 2 or 3 thick, posteriorly directed setae (fig. 44sp). Anal fringe with 34–40 setae (fig. 45).

Discussion: *Chapinia traylori* resembles most closely *C. blakei*. The venter of the third femora and posterolateral margins of abdominal sternites IV–VI lack brushes in both sexes of *C. traylori* and in the male of *C. blakei*, but these margins have small scattered brushes of normal setae in females of *C. blakei*. The male genitalia have endomeres with paired plates in both *C. traylori* and *C. blakei*, but the posterior extension of the endomeres is split in *C. traylori* and not split in *C. blakei;* the paired plates may be split in *C. blakei*, giving the appearance of paired outer rims and inner plate, but the inner plate in this case is unsymmetrical. The female abdominal sternite VIII has a small triangular internal sclerite in *C. traylori* but a much larger sclerite with slender posteriorly divergent margins in *C. blakei*. Each lateral projection of the ventral sclerite between female vulva

and anus has fewer than four thick, posteriorly directed setae in *C. traylori* but more than four in all other *Chapinia*.

Material examined: 73 males and 52 females from fresh and dried material collected in the Philippines.

Type host: *Buceros hydrocorax semigaleatus* Tweeddale, 1878.

Type material: Holotype male, allotype female, and paratype female on same slide from CNHM skins from San Isidro, Samar Island, Philippines, April–May 1957, collected by D. S. Rabor, REE in CNHM. The allotype female is the largest female and is next to the male. Paratypes: 1 male and 1 female from CNHM skins from Cantaub, Sierra Bullones, Bohol Island, Philippines, April–May 1955, collected by D. S. Rabor, REE; 2 males from CNHM skins from Matuguinao, Samar Island, Philippines, April 1957, collected by D. S. Rabor, REE; 15 males and 9 females from CNHM skins from Mount Capato-an, Samar Island, Philippines, May 1957, collected by D. S. Rabor, REE; from *Buceros hydrocorax mindanensis* Tweeddale, 1877: 11 males and 12 females from Mutya, Canon, Mindanao Island, Philippines, Dec. 23, 1961, collected by Rabor and Gonzales, BPBM; 9 males and 7 females from Mount McKinley, Davao, Mindanao Island, Philippines, August 1946, collected by H. Hoogstraal, CNHM; 2 males and 3 females from CNHM skins from Taglawig, Tagum, Davao, Mindanao Island, Philippines, October 1946, collected by Celestino, REE; 13 males and 7 females from Mount Apo, Todaya, Mindanao Island, Philippines, Oct. 25, 1946, collected by Hoogstraal and Hey, CNHM; 2 males and 1 female from CNHM skins from Kidapawan, Cotabata, Mindanao Island, Philippines, Dec. 2, 1946, collected by Alcasid, REE; 1 male and 1 female from CNHM skins from Burungkot Upi, Cotabata, Mindanao Island, January 1947, collected by Werner and Alcasid, REE; 9 males and 4 females from CNHM skins from Mount Malindang, Zamboanga, Mindanao Island, Philippines, March–May 1956, collected by D. S. Rabor, REE; 2 males and 1 female from USNM skins from Mindanao Island, Philippines, August–September 1903, collected by E. A. Mearns, REE; 5 males and 4 females from Mindanao Island, Philippines.

Chapinia traylori is named for Dr. M. A. Traylor, Division of Birds, Chicago Natural History Museum, in appreciation for assistance in examination of hornbill skins for Mallophaga in that museum.

Chapinia lydae, new species

FIGURES 20, 46

"*Colpocephalum hirtum* Rudow, 1866."—Piaget, 1880, p. 530, pl. 44 (fig. 3). [Not Rudow, 1866; type host: *Buceros cassidix* = *Rhyticeros cassidix* (Temminck, 1823).]

Clay (1951b) stated that it was impossible to say whether or not

Piaget's specimens of a headless female and 2 nymphs from *Buceros cassidix=Rhyticeros cassidix* (Temminck, 1823) were conspecific with Rudow's *hirtum* from *Buceros ruficollis=Rhyticeros plicatus ruficollis* (Vieillot, 1816). Through the courtesy of Dr. Clay, Piaget's specimens have been examined, and they do not appear to be conspecific with *Chapinia hirta* (Rudow, 1866). They are described herewith as part of the type material from *Rhyticeros cassidix*.

Both sexes are smaller than corresponding sexes of *Chapinia traylori* in all measurements except length of head, but this measurement in the male is larger than in males of other *Chapinia* (tables 1, 2).

Male: Venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae which are not as numerous on abdominal sternite VI. Each lateral margin of abdominal tergites II–VI without a short seta between the spiracle and postspiracular seta. Abdominal sternite II with 62–64 total setae and three median rows of setae. Terminal abdominal segments similar to those of *C. boonsongi*. Genitalia as shown in figure 20, endomeres with inner plate and paired outer rims.

Female: Resembles the male except that abdominal sternite II has 54–68 total setae. Terminal abdominal tergite with 14 long and 8 short setae on posterior margin; abdominal sternite VIII with 20–24 setae on posterior margin (fig. 46). Anal fringe similar to that of *C. hirta*, with 46–50 setae.

Discussion: *Chapinia lydae* superficially resembles *C. hirta*. Abdominal sternite II in both species has approximately the same number of total setae in females as in males and three median rows of setae. Abdominal sternite II of other members of the *acutovulvata* species-group has more setae in the females than in the males and 1 or 2 median rows of setae. The male genitalia in *C. lydae* are wider than in *C. hirta*, and the parameres are enlarged anteriorly only in *C. lydae*; the endormeres have an inner plate and paired outer rims in *C. lydae*, but endomeres apparently are absent in *C. hirta*. The female terminal abdominal tergite has on the posterior margin in *C. lydae* 3 or 4 long setae on each side of the midline, the two median setae being as widely spaced as four times the distance between each of the 3 or 4 long setae, but in *C. hirta* 5 long setae on each side of the midline yield a total of 10 setae that are evenly spaced.

Material examined: 3 males and 5 females from dried skins collected in the Celebes.

Type material: Holotype male and allotype female from USNM skins from Palaleh River, Celebes, Aug. 9, 1914, collected by H. C. Raven, LE in USNM. Paratypes: 2 males and 3 females with same data; 1 female, Piaget, BMNH, 1928–325.

Chapinia lydae is named for my wife, Lyda, in appreciation for the

dried material that she obtained from *Rhyticeros cassidix* and other hosts in the USNM and for much help in preparation of the manuscript.

The *hirta* Species-Group

Species similar in shape to *Chapinia traylori* (figs. 25, 26). Differing from other species-groups in the following combination of characters: Dorsal-lateral margins of head with a preocular notch; venter of third femora and posterolateral margins of abdominal sternites IV–VI each with small scattered brushes of normal setae which are not as numerous on abdominal sternite VI; each lateral margin of abdominal tergites II–VI without a short seta between the spiracle and postspiracular seta; females with approximately the same number of abdominal sternal setae as males; abdominal sternite II with three median rows of setae; male genitalia much narrower than for other species-groups, without lateral horns on each side of endomeres, and with parameres not enlarged anteriorly but split posteriorly; females without sclerital hooks on each side of midline of ventral sclerite between vulva and anus; female abdominal sternite VIII with most of setae much shorter than those on posterior margin.

Hosts: Species of the *hirta* species-group have been found only on the genera *Penelopides* and *Rhyticeros* of the avian family Bucerotidae.

Chapinia muesebecki, new species

FIGURES 18, 21

Male: Smaller than *Chapinia traylori* in all measurements except length of head (table 1). Abdominal sternite II with 58–62 total setae. Terminal abdominal segments as shown in figure 21. Genitalia as shown in figure 18.

Female: Unknown.

Discussion: *Chapinia muesebecki* resembles most closely *C. hirta*. Male terminal abdominal segments are shorter in *C. muesebecki* than in *C. hirta*, and the partial division between abdominal sternites VII and VIII is not as pronounced in *C. muesebecki* as in *C. hirta*. The sclerite of male genital sac is nearly twice as long as wide in *C. muesebecki* but approximately as wide as long in *C. hirta*, and this sclerite is approximately three times as long in *C. muesebecki* as in *C. hirta*.

Material examined: 2 males from dried skins collected in the Celebes.

Type host: *Penelopides e. exarhatus* (Temminck, 1823).

Type material: Holotype male from USNM skins from Celebes, 1914–1916, collected by H. C. Raven, REE in USNM. Paratype male with same data.

Chapinia muesebecki is named for Mr. C. F. W. Muesebeck, Division of Insects, U.S. National Museum, in appreciation for the loan of Mallophaga from that museum.

Chapinia hirta (Rudow)

FIGURES 19, 22, 47, 48

Colpocephalum hirtum Rudow, 1866, p. 474. [Type host: *Buceros ruficollis* = *Rhyticeros plicatus ruficollis* (Vieillot, 1816).]
Colpocephalum hirtum Rudow, 1869, p. 399.
Chapinia hirta (Rudow).—Hopkins and Clay, 1952, p. 67.

Hopkins and Clay state that the generic position of *hirtum* is doubtful. Examination of specimens from the type host shows them to be *Chapinia*. Therefore, the male, BM 13376, is designated hereby as neotype of *C. hirta*. The slide has been so labeled.

Both sexes are smaller than corresponding sexes of *Chapinia traylori* in all measurements except length of head (tables 1, 2).

Male: Abdominal sternite II with 60–64 total setae. Terminal abdominal segments as shown in figure 22. Genitalia as shown in figure 19.

Female: Resembles the male except that terminal abdominal segments have a tergite with 12 long and 10 short setae on posterior margin; abdominal sternite VIII has 18–22 setae on posterior margin (fig. 48). Anal fringe with 46–48 setae (fig. 47).

Discussion: *Chapinia hirta* resembles most closely *C. muesebecki*. Also, *C. hirta* superficially resembles *C. lydae*. Abdominal sternite II in these three species has approximately the same number of total setae in females as in males, and three median rows of setae. Male terminal abdominal segments are longer in *C. hirta* than in *C. muesebecki*, and the partial division between abdominal sternites VII and VIII is more pronounced in *C. hirta* than in *C. muesebecki*. The sclerite of male genital sac is approximately as wide as long in *C. hirta* but nearly twice as long as wide in *C. muesebecki*, and this sclerite is approximately one-third as long in *C. hirta* as in *C. muesebecki*. The male genitalia in *C. hirta* are narrower than in *C. lydae;* the parameres, straight-sided in *C. hirta*, are enlarged anteriorly in *C. lydae;* the endomeres apparently are absent in *C. hirta*, but have an inner plate and paired outer rims in *C. lydae*. The female terminal abdominal tergite has on the posterior margin in *C. hirta* 5 long setae on each side of the midline, these 10 setae being evenly spaced; however, in *C lydae* 3 or 4 long setae on each side of the midline have the two median setae as widely spaced as four times the distance between each of the 3 or 4 long setae.

Material examined: 3 males and 2 females from fresh and dried material collected in the Oriental and Australasian regions; neotype male, BM 13376, and female, BM 13375, from New Guinea, BMNH;

from *Rhyticeros plicatus subruficollis* (Blyth, 1843): 1 female from USNM skins from Domel Island, Mergui Archipelago, 1904, collected by W. L. Abbott, REE; from *Rhyticeros plicatus mendanae* (Hartert, 1924): 1 male from CNHM skins from Guadalcanal, Solomon Islands, August–October 1944, collected by W. J. Beecher, REE; 1 male from MMZ skin from Guadalcanal, Solomon Islands, Jan. 20, 1944, collected by K. W. Prescott, REE.

Drawings were made of the neotype male and the female, BM 13375. Specimens in BMNH.

Bucerocolpocephalum, new genus

FIGURES 64, 65

Head triangular, width 1¼ to 1⅓ times that of length. Forehead slightly narrower anteriorly. Temples expanded. Antennae 4-jointed, third segment constricted at base, and terminal segment capitate with definite signs of division into two parts, either by transverse line or marginal indentation. Antennary fossa deep, covered above by expansion of lateral margin of head, posterior margin of which lacks an eye. Dorsal-lateral margin of forehead above antennary fossa with shallow notch. Gular region narrow with a ridge on each lateral margin from which 8–11 setae extend. Pronotum expanded anteriorly with posterior marginal row of long setae. Metanotum expanded posteriorly with posterior marginal row of long setae and 4–7 short setae on each lateral margin. Metanotum separated from mesonotum and from pleurites. The sclerotized median button behind the prothorax (fig. 25m) is a vestige of the mesonotum; the supposed mesonotum, the narrow sclerotized band posterior to this button, is a mere extension of the subcoxae (Cope, 1941). Thoracic sternal plates as shown in figures 64b and 64c. Metasternal plate oval with 14–24 setae. Venter of third femora and posterolateral margins of abdominal sternite IV each with combs of setae. Abdominal segments consist of tergites, sternites, and pleurites, the latter without prolongation of posteroventral angles. Abdominal tergites each with a posterior marginal row of setae, the most laterad being the postspiracular seta. Each lateral margin of abdominal tergites II–VIII with 1–4 short setae between the spiracle and postspiracular seta. Sternites and pleurites each with a posterior marginal row of long and short setae and with numerous short, usually thick setae. Male terminal abdominal sternites VIII and IX fused with complete division from sternite VII (fig. 65). Male genitalia as illustrated for each species with parameres anteriorly either enlarged or curved inwardly. Female terminal abdominal segments as illustrated for each species, with lateral processes arising from ventral

sclerite between vulva and anus, with long stout setae and strong spines. Females similar to males in size, general shape, and chaetotaxy except for terminal abdominal segments.

Bucerocolpocephalum resembles most closely *Bucerophagus* (figs. 66–69) but differs in several characters: The posterior margin of the expansion of the lateral margin of the head covering the antennary fossa lacks an eye in *Bucerocolpocephalum*, but an eye with a double cornea is present in *Bucerophagus*. The gular region has on each lateral ridge 8–11 setae in *Bucerocolpocephalum*, but the ridge is absent, and each lateral margin has at most eight setae in *Bucerophagus*. The matasternal plate is oval in *Bucerocolpocephalum* but trapezoidal or triangular in *Bucerophagus*. The venter of the third femora has combs of setae in *Bucerocolpocephalum* but may have large thick brushes of normal setae in *Bucerophagus;* similar combs are present on posterolateral margins of abdominal sternite IV in *Bucerocolpocephalum*, and similar brushes are present on posterolateral margins of abdominal sternites IV and V in *Bucerophagus*. Male genitalia of *Bucerocolpocephalum* are shorter than in *Bucerophagus*. The female anal fringe is weak in *Bucerocolpocephalum* and prominent in *Bucerophagus*.

The male genitalia and details of the male and female terminal abdominal segments are the best characters for separating species of *Bucerocolpocephalum*.

Hosts: Species of *Bucerocolpocephalum* have been found only on the genera *Ptilolaemus* and *Anorrhinus* of the avian family Bucerotidae. [Genotype: *Bucerocolpocephalum emersoni*, new species.]

Bucerocolpocephalum emersoni, new species

FIGURES 49, 57, 64, 65

Both sexes are approximately the same size as corresponding sexes of *Bucerocolpocephalum deignani* (table 3).

Male: As illustrated in figure 65. Metasternal plate with 16–20 setae. Abdominal sternite II with 40–48 total setae. Terminal abdominal segments as shown in figure 65e. Genitalia as shown in figure 57.

Female: As illustrated in figure 64. Resembles the male except that metasternal plate has 16–24 setae. Terminal abdominal tergite with 30–36 setae on posterior margin; abdominal sternite VIII with 32–42 setae on posterior margin and with internal triangular sclerite; anal fringe with 44–48 weak setae (fig. 49).

Discussion: *Bucerocolpocephalum emersoni* resembles most closely *B. deignani*. Male terminal abdominal sternites VIII and IX have a lateral notch in *B. emersoni* but not in *B. deignani*. Male genitalia have parameres anteriorly slender, curved inwardly with each lateral

point reaching endomeres in *B. emersoni* and anteriorly enlarged, not curved inwardly, in *B. deignani;* endomeres have a pair of posterior points in *B. emersoni* which are absent in *B. deignani.* The female terminal abdominal tergite has thick setae along the entire posterior margin in *B. emersoni,* but thick setae are absent medially in *B. deignani.* The female abdominal sternite VIII has an internal triangular sclerite in *B. emersoni* that is absent in *B. deignani.*

Material examined: 13 males and 19 females from fresh and dried material collected in the Oriental region.

Type host: *Ptilolaemus tickelli austeni* (Jerdon, 1872).

Type material: Holotype male and allotype female from Phu Lom Lo Mt., Kok Sathon, Dan Sai, Loei, Thailand, Mar. 23, 1954, collected by Robert E. Elbel, USNM. Paratypes: 8 males and 15 females with same data; from *Ptilolaemus tickelli indochinensis* Delacour and Jabouille, 1928: 4 males and 3 females from CNHM skins from Muong Yo, Laos, and Muong Maun, Tonkin, Indochina, March–May 1929, collected by Van Tyne, REE.

Bucerocolpocephalum emersoni is named for Dr. K. C. Emerson, Stillwater, Okla., in appreciation for his untiring help and advice throughout this study, particularly in the preparation of the manuscript and illustrations, and in other studies on Oriental Mallophaga.

Bucerocolpocephalum deignani, new species

FIGURES 50, 58, 59

Both sexes are approximately the same size as corresponding sexes of *Bucerocolpocephalum emersoni* (table 3).

Male: Metasternal plate with 14–18 setae. Abdominal sternite II with 44–46 total setae. Terminal abdominal segments as shown in figure 59. Genitalia as shown in figure 58.

Female: Resembles the male except that abdominal sternite II has 42–58 total setae. Terminal abdominal tergite with 28–34 setae on posterior margin; abdominal sternite VIII with 34–42 setae on posterior margin; anal fringe with 24–40 weak setae (fig. 50).

Discussion: *Bucerocolpocephalum deignani* resembles most closely *B. emersoni.* Male terminal abdominal sternites VIII and IX lack the lateral notch in *B. deignani* that is present in *B. emersoni.* Male genitalia have parameres anteriorly enlarged, not curved inwardly, in *B. deignani* and anteriorly slender, curved inwardly with each lateral point reaching endomeres in *B. emersoni;* endomeres lack the pair of posterior points in *B. deignani* that are present in *B. emersoni.* The female terminal abdominal tergite lacks thick setae medially on the posterior margin in *B. deignani,* but thick setae are present along this entire margin in *B. emersoni.* The female abdominal sternite

VIII lacks the internal triangular sclerite in *B. deignani* that is present in *B. emersoni*.

Material examined: 39 males and 28 females from fresh and dried material collected in the Oriental region.

Type host: *Anorrhinus g. galeritus* (Temminck, 1831).

Type material: Holotype male from CNHM skin from Kinabatangan, North Borneo, May 18, 1950, collected by D. D. Davis, REE in CNHM. Paratypes: 2 males with same data. Additional types from *Anorrhinus g. carinatus* (Blyth, 1845): Allotype female from USNM skins from Trang, Thailand, 1896 and 1899, collected by W. L. Abbott, REE in USNM. Paratypes: 1 male and 1 female with same data; 27 males and 18 females from Lamo and Chong, Muang, Trang, Thailand, March 1963, collected by Wichit Suwan Laong, USNM; 8 males and 7 females from Na Wong, Ban Na, Muang, Phatthalung, Thailand, Mar. 6, 1963, collected by Wichit Suwan Laong, USNM: 1 female from BL skin from Khao Phap Pha Mt., Ban Na, Muang, Phatthalung, Thailand, Sept. 4, 1954, collected by B. Lekagul, REE.

Bucerocolpocephalum deignani is named for Mr. H. G. Deignan, Division of Birds, U.S. National Museum, in appreciation for the fresh material he collected in Thailand, for supplying identifications and information on hosts, and for permission to examine hornbill skins for Mallophaga in the USNM.

Genus *Bucerophagus* Bedford

FIGURES 66–69

Bucerophagus Bedford, 1929, p. 509, figs. 11, 12. [Genotype: *Bucerophagus africanus* Bedford, 1929.]

Antimenopon Eichler, 1947, p. 3, figs. 3–5. [Genotype: *Menopon forcipatum* Nitzsch, 1874.]

Head triangular, width 1¼ to 1¾ times that of length. Forehead narrower anteriorly. Temples expanded. Antenna 4-jointed, third segment constricted at base, and terminal segment capitate with definite signs of division into two parts, either by transverse line or marginal indentation. Antennary fossa deep, covered above by expansion of lateral margin of head, posterior margin of which bears eye with double cornea. Dorsal-lateral margin of forehead anterior to eye with shallow notch, Gular region with 2–8 setae varying in length on each lateral margin. Pronotum expanded anteriorly with posterior marginal row of long setae. Metanotum expanded posteriorly with posterior marginal row of long setae and 2–5 short setae on each lateral margin. Metanotum separated from mesonotum and from pleurites. The sclerotized median button behind the prothorax (fig. 25m) is a

vestige of the mesonotum; the supposed mesonotum, the narrow sclerotized band posterior to this button, is a mere extension of the subcoxae (Cope, 1941). Thoracic sternal plates as shown in figures 66b, 66c, 68b, 68c, and 70. Metasternal plate trapezoidal or triangular, expanded anteriorly, with 6–34 setae. Venter of third femora and posterolateral margins of abdominal sternites IV and V each with or without large thick brushes of normal setae. Abdominal segments consist of tergites, sternites, and pleurites, the latter without prolongation of posteroventral angles. Abdominal tergites each with a posterior marginal row of setae, the most laterad being the postspiracular seta. Each lateral margin of abdominal tergites II–VIII with or without 1–5 short setae between the spiracle and postspiracular seta. Sternites and pleurites each with a posterior marginal row of long setae and with numerous shorter setae. Male terminal abdominal sternites VIII and IX either fused or not but with complete division from abdominal sternite VII (figs. 67, 69). Male genitalia as illustrated for each species with parameres branched anteriorly and either split or unsplit posteriorly. Female terminal abdominal segments as illustrated for each species with lateral processes arising from ventral sclerite between vulva and anus with long stout setae and strong spines. Females larger than males, usually with more abdominal sternal setae but general shape and chaetotaxy similar to that of males except for terminal abdominal segments.

Bucerophagus resembles both *Chapinia* (figs. 23–26) and *Bucerocolpocephalum* (figs. 64, 65) but differs in several characters: The terminal segment of the antenna shows definite signs of division into two parts either by transverse line or marginal indentation in *Bucerophagus* and *Bucerocolpocephalum*, but there is no sign of division in *Chapinia*. The posterior margin of the expansion of the lateral margin of the head covering the antennary fossa has an eye with a double cornea in *Bucerophagus* and *Chapinia*, but an eye is absent in *Bucerocolpocephalum*. The gular region lacks a lateral ridge and each lateral margin has at most 8 setae in *Bucerophagus* and *Chapinia*, but each lateral ridge has 8–11 setae in *Bucerocolpocephalum*. The metasternal plate is trapezoidal or triangular in *Bucerophagus* and *Chapinia* but oval in *Bucerocolpocephalum*. The venter of the third femora may have brushes of normal setae in *Bucerophagus* and *Chapinia* but has combs of setae in *Bucerocolpocephalum*; similar brushes are present on posterolateral margins of abdominal sternites IV and V in *Bucerophagus* and abdominal sternites IV–VI in *Chapinia*, but combs of setae are present on posterolateral margins of abdominal sternite IV in *Bucerocolpocephalum*. Each lateral margin of abdominal tergites II–VIII may have 1–5 short setae between the spiracle and postspiracular seta in *Bucerophagus* and *Bucerocolpocephalum*, but one

short seta may be present on margins of abdominal tergites II–VI in *Chapinia*. Male terminal abdominal sternites VIII and IX may be fused in *Bucerophagus* and *Bucerocolpocephalum* with a complete division from abdominal sternite VII, but abdominal sternites VIII and IX are fused in *Chapinia* with a partial division only from abdominal sternite VII. Male genitalia of *Bucerophagus* are longer than in *Bucerocolpocephalum;* parameres are branched anteriorly in *Bucerophagus* but are slender or expanded anteriorly in *Chapinia*. Lateral processes arising from the ventral sclerite between the female vulva and anus have long stout setae and strong spines in *Bucerophagus* and *Bucerocolpocephalum* but only long stout setae in *Chapinia*. The female anal fringe prominent in *Bucerophagus* and *Chapinia* is weak in *Bucerocolpocephalum*.

The male genitalia and details of the male and female terminal abdominal segments are the best characters for separating species of *Bucerophagus*. Other characters useful in species separation are: The shape of the metasternal plate and the number of setae present; the presence or absence of brushes of normal setae on the venter of the third femora and posterolateral margins of abdominal sternites IV and V; the number present or absent of short setae on each lateral margin of abdominal tergites III–VIII between the spiracle and postspiracular seta; the total number of setae on each of abdominal sternites I and II. The number and length of setae on the lateral margins of the gular region are too variable to be of much use in separating species.

Eichler (1947) believed that the lack of brushes, the rounded projected lobe on the posterior end of the male abdomen, the specific male genital apparatus, and the female anal ring of setae were enough to place *Menopon forcipatum* Nitzsch in a separate genus. Hopkins and Clay (1952) correctly placed *M. forcipatum* in the genus *Bucerophagus*. Since there are several characters separating *B. forcipatus* from the complex *B. productus* and *B. africanus*, it is believed here that the relationship can be shown best by species-groups.

Hosts: Species of *Bucerophagus* have been found only on the genera *Buceros, Rhinoplax, and Bucorvus* of the avian family Bucerotidae.

The *forcipatus* Species-Group

As illustrated in figures 66, 67. Differing from the *productus* species-group in the following combination of characters: Head width 1½ to 1¾ times that of length; metanotum with two short setae on each lateral margin and without setae on anterior margin; metasternal plate with less than 14 setae; venter of third femora and abdominal sternites IV and V without brushes; each lateral margin of abdominal tergites II–VIII without short setae between the spiracle

and postspiracular seta; females with approximately the same number of abdominal sternal setae as males; both sexes having abdominal sternite I with fewer than 20 total setae and abdominal sternite II with fewer than 44 total setae; male terminal abdominal sternite IX projecting posteriorly as rounded lobe and with complete division from abdominal sternite VIII; male genitalia with parameres posteriorly split and curved inwardly; female terminal abdominal tergite with fewer than 12 setae on posterior margin; female abdominal sternite VIII with fewer than 24 setae on posterior margin.

Hosts: *Bucerophagus forcipatus* has been found only on the genera *Buceros* and *Rhinoplax* of the avian family Bucerotidae.

Bucerophagus forcipatus (Nitzsch)

FIGURES 51, 52, 60, 66, 67

Menopon forcipatum "Nitzsch."—Giebel, 1874, p. 289, pl. 15 (figs. 7, 8.) [Type host: *Buceros rhinoceros*=*Buceros rhinoceros sumatranus* Schlegel and Müller, 1840.]

Antimenopon forcipatum "Nitzsch in Giebel."—Eichler, 1947, pp. 3, 20, figs. 3-5.

Bucerophagus forcipatus (Nitzsch).—Hopkins and Clay, 1952, p. 64.

Eichler's description and figures are not recognizable. He designated specimens from *Buceros rhinoceros* from Sumatra as neotype material, but he did not select a neotype. His slide specimens have been remounted and examined; the male, 2275 ji, is designated hereby as neotype. The slide has been so labeled. The female, 2275 jf, is mounted on the same slide with the neotype.

Male: As illustrated in figure 67. Smaller than *Bucerophagus africanus* in all measurements except length of head and width of metathorax (table 12). Metasternal plate trapezoidal, expanded anteriorly, with 6–12 setae (fig. 66c). Abdominal sternite I with 6–18 total setae and abdominal sternite II with 30–36 total setae. Terminal abdominal segments as shown in figure 67d. Genitalia as shown in figure 60.

Female: As illustrated in figure 66. Smaller than *Bucerophagus africanus* in all measurements except width of metathorax (table 12). Resembles the male except that abdominal sternite II has 34–42 total setae. Terminal abdominal tergite with 8 long and 2 short setae on posterior margin; abdominal sternite VIII with 18–22 long and 4 short setae on posterior margin (fig. 51). Anal fringe with 44–54 setae (fig. 52).

Material examined: 49 males and 66 females from fresh and dried material collected in the Oriental region; neotype male and specimens from the same series, 1 male and 4 females, from WEC 2275, SMNH. According to Eichler (1947), WEC 2275 was collected in Sumatra by E. Mjöberg; from the type host: 23 males and 29 females from

USNM skins from Tarussan Bay, West Sumatra, 1904–1905, collected by W. L. Abbott, REE; from *Buceros rhinoceros borneoensis* Schlegel and Müller, 1840: 1 male and 6 females from Serabang Bay, Sarawak, Borneo, Jan. 11, 1958, BMNH 1958–737; 4 females from Borneo, Meinertzhagen 10890, BMNH; 2 males and 5 females from CNHM skin from Sapagayo Forest Reservation, Sandakan, North Borneo, July 27, 1950, collected by R. F. Inger and D. D. Davis, REE; from *Buceros bicornis homrai* Hodgson, 1832: 7 males and 5 females from Ban Khlua Klang, Prachuap Khiri Khan, Thailand, December 1952, collected by Robert E. Elbel, and H. G. Deignan, USNM; 11 males and 8 females from Khlong Khlung, Kamphaeng Phet, Thailand, Apr. 7, 1953, collected by Robert E. Elbel and H. G. Deignan, USNM; 1 male and 3 females from Ban Muang Khai, Tha Li, Loei, Thailand, Dec. 7, 1953, collected by Robert E. Elbel, USNM; 2 males and 1 female from Banghin, Kapoe, Ranong, Thailand, Feb. 6, 1963, collected by Wichit Suwan Laong, USNM; from *Rhinoplax vigil* (J. R. Forster, 1781): 1 female from Borneo, Meinertzhagen 10888, BMNH.

Drawings were made of a male and a female from *Buceros bicornis homrai* collected in Khlong Khlung, Thailand. Specimens in USNM.

The *productus* Species-Group

Species similar in shape to *Bucerophagus africanus* (figs. 68, 69). Differing from the *forcipatus* species-group in the following combination of characters: Head width 1¼ to 1½ times that of length; metanotum with 3–5 short setae on each lateral margin and with 6–8 setae on anterior margin; metasternal plate with more than 20 setae; venter of third femora and posterolateral margins of abdominal sternites IV and V each with thick brushes of normal setae; each lateral margin of abdominal tergites II–VIII with 1–5 short setae between the spiracle and postspiracular seta; females with more abdominal sternal setae than males; both sexes having abdominal sternite I with more than 20 total setae and abdominal sternite II with more than 60 total setae; male terminal abdominal sternites VIII and IX neither projecting posteriorly as rounded lobe nor with division but with complete division from abdominal sternite VII; male genitalia with parameres straight and not split posteriorly; female terminal abdominal tergite with more than 24 setae on posterior margin; female abdominal sternite VIII with more than 28 setae on posterior margin.

Hosts: Species of the *productus* species-group have been found only on the genus *Bucorvus* of the avian family Bucerotidae.

Bucerophagus productus (Burmeister)

FIGURES 53, 54, 61, 62, 70

Colpocephalum productum Burmeister, 1838, p. 439. [Type host: *Buceros abyssinicus*=*Bucorvus abyssinicus* (Boddaert, 1783).]
Colpocephalum vittatus Giebel, 1866, p. 394 (nomen nudum).
Colpocephalum productum "Nitzsch."—Giebel, 1874, p. 266, pl. 14 (figs. 2, 3).
Colpocephalum eurygaster Piaget, 1888, p. 162, pl. 4 (fig. 5). [Type host: *Leptoptilus argala* error=*Bucorvus abyssinicus*.]
Bucerophagus productus "Nitzsch in Burmeister"—Conci, 1950, p. 78, figs. 1-7.
Bucerophagus productus (Burmeister).—Hopkins and Clay, 1952, p. 64.

A neotype, in the Zoologischen Institute der Universität Halle, Germany, was erected by Conci, who redescribed and figured *Bucerophagus productus* from *Bucorvus abyssinicus* collected in east Africa by Prof. E. Zavattari. A male from the same series is in the collection of Mr. G. H. E. Hopkins, Zoological Museum, Tring, Hertsfordshire, England.

A lectotype male was designated by Clay (1951a) from the *Colpocephalum eurygaster* syntypes in the Piaget collection, and it is now in the British Museum (Natual History), BM 1157a, with 3 syntype males and 1 syntype female, BM 1157 and 1158.

Clay (1951a) stated that *Bucerophagus productus* also seemed to occur naturally on *Bucorvus leadbeateri* (Vigors).

Male: Smaller than *Bucerophagus africanus* in all measurements except length of head; approximately the same size as *B. forcipatus* (table 12). Metasternal plate triangular, expanded anteriorly, with 22–26 setae (fig. 70). Each lateral margin of abdominal tergites III–VIII with 2–4 short setae between the spiracle and postspiracular seta except for tergite VII with 1 or 2 setae and tergite VIII with one seta. Abdominal sternite I with 22–24 total setae and abdominal sternite II with 66–68 total setae. Terminal abdominal segments as shown in figure 61. Genitalia as shown in figure 62, with branch connecting parameres posterior to endomeres pointed medially.

Female: Approximately the same size as *Bucerophagus africanus*; larger than *B. forcipatus* in all measurements except width of head and width of metathorax (table 12). Resembles the male except that metasternal plate has 26–34 setae. Abdominal sternite I with 28 total setae and abdominal sternite II with 74–76 total setae. Terminal abdominal tergite with 26–38 setae on posterior margin; abdominal sternite VIII with 30–36 setae on posterior margin (fig. 53). Anal fringe with 42–56 setae (fig. 54).

Discussion: *Bucerophagus productus* resembles most closely *B. africanus* which, however, is much more pigmented than *B. productus*. Males of *B. productus* are much smaller than females, but males of *B. africanus* are only slightly smaller than females. The metasternal plate is triangular in *B. productus* and trapezoidal in *B. africanus*;

this plate has fewer setae in both sexes of *B. productus* than in corresponding sexes of *B. africanus*. Each lateral margin of abdominal tergites III-VI between the spiracle and postspiracular seta has more short setae in males and fewer in females of *B. productus* than in corresponding sexes of *B. africanus*. Abdominal sternite I has approximately one-half the number of setae in both sexes of *B. productus* as in corresponding sexes of *B. africanus*; abdominal sternite II has slightly more setae in males and slightly fewer setae in females of *B. productus* than of *B. africanus*. The male abdominal sternite VIII lacks the central T-shaped plate in *B. productus* which is present in *B. africanus* (fig. 69d). The male genitalia has the internal branch connecting the parameres posterior to the endomeres pointed medially in *B. productus* but rounded in *B. africanus*. The female anal fringe has fewer than 58 setae in *B. productus* but more than 58 setae in *B. africanus*.

Comparison on different hosts: No morphological differences were found between specimens of *Bucerophagus productus* found on the two hosts, *Bucorvus abyssinicus* and *B. leadbeateri*, so standard measurements were tested against the null hypothesis that there were no differences in measurements (tables 4–7).

Terminology and formulae are as follows:

$\bar{x}_1$=mean measurement of *B. productus* specimens on host 1, *Bucorvus abyssinicus*

$\bar{x}_2$=mean measurement of *B. productus* specimens on host 2, *Bucorvus leadbeateri*

D=difference in mean measurements, $(\bar{x}_1-\bar{x}_2)$ or $(\bar{x}_2-\bar{x}_1)$

s^2=variance$=\frac{S(x-\bar{x})^2}{N-1}=\frac{Sx^2-(Sx)^2/N}{N-1}$

s_1^2=variance of measurements of *B. productus* specimens on host 1, *B. abyssinicus*

s_2^2=variance of measurements of *B. productus* specimens on host 2, *B. leadbeateri*

F=the ratio of the larger variance divided by the smaller$=\frac{s_1^2}{s_2^2}$ or $\frac{s_2^2}{s_1^2}=\frac{N_n}{N_d}$

SE=Standard Error of $D=\sqrt{\frac{S(x-\bar{x}_1)^2+S(x-\bar{x}_2)^2}{N_n+N_{d-2}}\left(\frac{1}{N_n}+\frac{1}{N_d}\right)}$

CL=Confidence Limits for $D=D\pm(SE)$ (t.05)

Since it is not possible by measurements alone to decide from which host specimens came, populations from two hosts are considered conspecific.

Material examined: 39 males and 44 females from fresh and dried material collected in the Ethiopian region; from the type host: 4 males and 2 females from Gula, Uganda, Africa, July 10, 1936, collected by G. H. E. Hopkins, GHEH; 6 females from Ethiopia, Africa, March 1909, BMNH 3673; 1 female from CNHM skin from Africa, Jan. 30, 1946, REE; 3 males and 1 female from USNM skins from Sirre, Ethiopia, Africa, Feb. 13, 1912, collected by Childs Frick, REE; 3 males from USNM skins from Uganda, Africa, January–

February 1910, collected by E. A. Mearns, REE; from *Bucorvus leadbeateri* (Vigors, 1825): 9 males and 18 females from CNHM skins from Chitau, Bihe, Angola, Africa, 1932–1934, collected by Jean Bodaly, REE; 15 males and 14 females from CNHM skin from Pondi, Benguela, Angola, Africa, Sept. 14, 1936, collected by K. H. Prior, REE; 5 males and 2 females from CNHM skins from Kari Pan, Makari, Bechuanaland, Africa, August 1930, collected by Vernay, Lang, and Roberts, REE.

Drawings were made of a male and a female from the type host collected in Gula, Uganda, Africa. Specimens in GHEH.

Bucerophagus africanus Bedford

FIGURES 55, 56, 63, 68, 69

Bucerophagus africanus Bedford, 1929, p. 509, figs. 11, 12. [Type host: *Bucorvus schlegeli* Roberts = *Bucorvus leadbeateri* (Vigors, 1825).]
Bucerophagus africanus Bedford—Hopkins and Clay, 1952, p. 64.

Clay (1951a) stated that according to Mr. G. H. E. Hopkins *Bucerophagus africanus* also occurred on *Bucorvus abyssinicus*.

Male: As illustrated in figure 69. Larger than either *Bucerophagus forcipatus* or *B. productus* except for length of head (table 12). Metasternal plate trapezoidal, expanded anteriorly, with 30–34 setae (fig. 68c). Each lateral margin of abdominal tergites III–VIII with two short setae between the spiracle and postspiracular seta except for tergites III and VIII each with one short seta. Abdominal sternite I with 40 total setae and abdominal sternite II with 62 total setae. Abdominal sternite VIII with central T-shaped plate (fig. 69d). Genitalia as shown in figure 63.

Female: As illustrated in figure 68. Approximately the same size as *Bucerophagus productus:* larger than *B. forcipatus* in all measurements except width of metathorax (table 12). Resembles the male except that metasternal plate has 36–42 setae. Each lateral margin of abdominal tergites III–VIII with 3–5 short setae between the spiracle and postspiracular seta except for tergite VIII with one seta. Abdominal sternite I with 50 total setae and abdominal sternite II with 86 total setae. Terminal abdominal tergite with 32–40 setae on posterior margin; abdominal sternite VIII with 28–38 setae on posterior margin (fig. 55). Anal fringe with 60–66 setae (fig. 56).

Discussion: *Bucerophagus africanus* resembles most closely *B. productus* which, however, is not as pigmented as *B. africanus*. Males of *B. africanus* are only slightly smaller than females, but males of *B. productus* are much smaller than females. The metasternal plate is trapezoidal in *B. africanus* and triangular in *B. productus;* this plate has more setae in both sexes of *B. africanus* than in corresponding

sexes of *B. productus*. Each lateral margin of abdominal tergites III-VI between the spiracle and postspiracular seta has fewer short setae in males and more in females of *B. africanus* than in corresponding sexes of *B. productus*. Abdominal sternite I has approximately twice the number of setae in both sexes of *B. africanus* as in corresponding sexes of *B. productus;* abdominal sternite II has slightly fewer setae in males and slightly more setae in females of *B. africanus* than of *B. productus*. The male abdominal sternite VIII has a central T-shaped plate in *B. africanus* which is absent in *B. productus*. The male genitalia has the internal branch connecting the parameres posterior to the endomeres rounded medially in *B. africanus* but pointed in *B. productus*. The female anal fringe has more than 58 setae in *B. africanus* but fewer than 58 setae in *B. productus*.

Comparison on different hosts: No morphological differences were found between specimens of *Bucerophagus africanus* found on the two hosts, *Bucorvus abyssinicus* and *B. leadbeateri*, so standard measurements were tested against the null hypothesis that there were no differences in measurements (tables 8–11).

Terminology and formulae were the same as those used for *Bucerophagus productus* except as follows:

$\bar{x}_1$=mean measurement of *B. africanus* specimens on host 1, *Bucorvus abyssinicus*
$\bar{x}_2$=mean measurement of *B. africanus* specimens on host 2, *Bucorvus leadbeateri*
s_1^2=variance of measurements of *B. africanus* specimens on host 1, *Bucorvus abyssinicus*
s_2^2=variance of measurements of *B. africanus* specimens on host 2, *Bucorvus leadbeateri*

Since it is not possible by measurements alone to decide from which host specimens came, populations from two hosts are considered conspecific.

Material examined: 13 males and 13 females from fresh and dried material collected in the Ethiopian region; from the type host: 1 female from Mafa, South-West Africa, February 1923, BMNH; 9 males and 7 females from Cameroons Zoo, Africa, November 1936, BMNH 8127; 1 female from CNHM skins from Kari Pan, Makari, Bechuanaland, Africa, August 1930, collected by Vernay, Lang, and Roberts, REE; from *Bucorvus abyssinicus* (Boddaert, 1783): 1 male and 1 female from Koubadge, French Cameroons, Africa, July 1947, collected by V. Aellen, BMNH 1954–487; 2 males and 2 females from USNM skins from Sirre, Ethiopia, Africa, Feb. 13, 1912, collected by Childs Frick, REE; 1 male and 1 female from Nyala, Sudan, Africa, Feb. 12, 1949, KCE.

Drawings were made of a male and a female from the type host collected in the Cameroons Zoo. Specimens in BMNH.

Aviparasitological Relationships

Since Mallophaga are obligatory, usually highly host-specific, external parasites, their distribution is dependent on the distribution of their hosts (Emerson and Ward, 1958). The arrangement of the Mallophaga based on morphological similarities does not follow exactly Peters' (1945) phylogenetic arrangement of the hornbill hosts (table 13). In the genus *Chapinia*, species of the *lophocerus* species-group infest hosts in the genera *Tockus*, *Bycanistes*, and *Ceratogymna* of the Ethiopian region, but species of the *acutovulvata* and *hirta* species-groups infest hosts in the genera *Tockus*, *Anorrhinus*, *Penelopides*, *Rhyticeros*, *Anthracoceros*, and *Buceros* of the Oriental and Australasian regions. Species of *Bucerocolpocephalum* infest hosts in the genera *Ptilolaemus* and *Anorrhinus* of the Oriental region. In the genus *Bucerophagus*, the species *B. forcipatus* of the *forcipatus* species-group infests hosts in the genera *Buceros* and *Rhinoplax* of the Oriental region, but species of the *productus* species-group infest hosts in the genus *Bucorvus* of the Ethiopian region.

Tockus is the only hornbill genus with amblyceran lice that has members in both the Ethiopian and Oriental regions (table 13). Yet the amblyceran, *Chapinia clayae*, from the Oriental species, *Tockus birostris* and *Tockus g. griseus*, does not resemble members of the *lophocerus* species-group which infest other species of *Tockus*. Instead, *C. clayae* resembles most closely *C. acutovulvata* from the Oriental species of *Anthracoceros*. It would appear that there has been more recent contact between the Indian *Tockus* and *Anthracoceros* whose ranges overlap than between the more nearly related Indian *Tockus* and African *Tockus*. Kellogg (1896) was the first to mention that Mallophaga live their entire lives on the host bird and that infestation of new hosts is accomplished by the actual migration of individuals from one bird to another, during copulation, nesting, or roosting. Clay (1949b) stated that normally birds of different species did not come into close enough contact for lice to be transferred from host to host but that interchange of lice could take place between predator and prey, nestling and foster parent in brood parasites, by the use of common dust baths (according to Hoyle, 1938), and by phoresy, which is the transfer of lice by Hippoboscid flies. In the case of brood parasites she stated that for the European Cuckoo, *Cuculus canorus*, lice of the foster parents had never been established on the cuckoo. She further stated that establishment on the new host might be prevented by competition of the already adapted resident louse population, by the host specificity of the immigrant louse making feeding and development on the new host impossible, or by the fact that only males or unfertilized females had been introduced. Clay (1962) described natural straggling as

occurring between hosts that happened to be nesting in close proximity; she stated that establishment on the new host might be facilitated by the absence of a resident louse.

It would appear that both *lophocerus* and *acutovulvata* species-groups shared a common ancestor of *Chapinia* on *Tockus* before the Indian and African *Tockus* became separated. Once separated, the *Chapinia* evolved as did the birds to the recognized species within each species-group. Natural straggling may have accounted for establishment on some of the hosts.

Clay (1949b) mentioned that the chief factor influencing the production of allopatric species and genera of Mallophaga has been the successive splitting of the host populations during the evolution of the birds, thus leaving isolated louse populations. The louse population is considered as comprising all individuals that can interbreed because their hosts can interbreed (Clay, 1958). Kellogg (1896) stated that with the spreading of the ancestral bird species, geographical races arose within the limits of the species. With time and isolation, these races became distinct species which were often distinguished only by superficial differences in color, etc. The Mallophaga remained practically unaffected since their environment was essentially unchanged. The environment of the Mallophaga, the physical and chemical composition of the feathers and blood, changes more slowly than do other factors leading toward speciation of the bird; until this environment changes, the Mallophaga would remain unchanged (Clay, 1949b). For example, in the *acutovulvata* species-group, the hosts *Anthracoceros coronatus* and *A. convexus* are now considered to be full species distinct from *A. a. albirostris*, *A. a. leucogaster*, and *A. marchei*, yet all these hosts bear the same species of Mallophaga, *Chapinia acutovulvata*. Similarly, in the *lophocerus* species-group, *Chapinia bucerotis* infests eight subspecies in four species of *Bycanistes*, and *C. lophocerus* infests six subspecies in four species of *Tockus*. In the *forcipatus* species-group, *Bucerophagus forcipatus* infests three subspecies in three species and two genera.

Although *Anthracoceros marchei* is restricted to the Philippines, it is host to *Chapinia acutovulvata* which infests other *Anthracoceros* species with wider distribution in the Oriental region. *A. montani* also is restricted to the Philippines, but its amblyceran parasite, *C. hoplai*, resembles most closely *C. boonsongi* from *Rhyticeros undulatus*, which is distributed elsewhere in the Oriental region. *Chapinia wenzeli* from *Penelopides panini* and *C. traylori* from *Buceros hydrocoraz* both resemble most closely *C. blakei* from *Rhyticeros leucocephalus*. Although the host genus *Buceros* is not considered to be as related to *Rhyticeros* as is *Penelopides*, the host species from which *C. wenzeli*, *C. blakei*, and *C. traylori* were obtained are all restricted

to the Philippines. Thus, *C. traylori* may have evolved as a result of natural straggling from the stock that gave rise to *C. wenzeli* and *C. blakei* and subsequently became established on the host *B. hydrocorax*.

Chapinia lydae from *Rhyticeros cassidix* has the characters of the *acutovulvata* species-group but superficially resembles members of the *hirta* species-group of which *C. muesebecki*, from *Penelopides e. exarhatus*, like *C. lydae*, is restricted to the Australasian region (table 13). *Chapinia hirta*, the other member of the *hirta* species-group, infests subspecies of *Rhyticeros plicatus* in both the Oriental and Australasian regions.

The hornbill genus *Buceros* is host to both *Chapinia* and *Bucerophagus* (table 13); however, these Mallophaga do not infest the same hosts. *Buceros hydrocorax*, the host of *Chapinia traylori*, is restricted to the Philippines, but *B. rhinoceros* and *B. bicornis*, the hosts of *Bucerophagus forcipatus*, are distributed elsewhere in the Oriental region. On the other hand, the mallophagan species, *Chapinia waniti* and *Bucerocolpocephalum deignani*, do infest the same host, *Anorrhinus galeritus carinatus*.

In the *productus* species-group both *Bucerophagus productus* and *B. africanus* infest the two hosts, *Bucorvus abyssinicus* and *B. leadbeateri*. The population of each mallophagan species on each host could not be separated morphologically or statistically. Thus, only the two species, *Bucerophagus productus* and *B. africanus*, could be recognized. Similarly, Clay (1955) recognized only the one species, *Bucorvellus docophorus*, although specimens from *Bucorvus leadbeateri* showed a tendency to be smaller in size than specimens from *B. abyssinicus*. She further stated that it would be expected from Harrison's rule (1915) that specimens from *B. leadbeateri*, the smaller host, would be smaller than specimens from the larger *B. abyssinicus*. However, Mackworth-Praed and Grant (1952) stated that *B. leadbeateri* was the largest of the Hornbills; they gave wing measurements for *B. leadbeateri* as 509–595 mm. and for *B. abyssinicus* as 495–595 mm.

Harrison (1915) stated the rule that bears his name: that in general, when a mallophagan genus is well distributed over a considerable number of nearly related hosts, the size of the parasite is roughly proportional to the size of the host. *Chapinia camuri*, the smallest species of *Chapinia*, infests the smallest hornbill, *Tockus camurus*, but *Chapinia traylori*, the largest species of *Chapinia*, does not infest *Rhyticeros undulatus*, the largest host for species of *Chapinia*.

Summary

Amblyceran Mallophaga of the family Menoponidae were examined from 53 species or subspecies of hornbills. Descriptions and illustrations are presented for 22 species in three genera of hornbill Menoponidae of which 14 species are new. The genus *Chapinia* now contains three species-groups and 17 species of which 12 are new. The genus *Bucerophagus* now contains two species-groups and three species. The new genus *Bucerocolpocephalum* type *emersoni* is erected here for two new comb-bearing species. The new species are as follows: *Chapinia fasciati*, *C. camuri*, *C. clayae*, *C. waniti*, *C. malayensis*, *C. hoplai*, *C. boonsongi*, *C. wenzeli*, *C. blakei*, *C. traylori*, *C. lydae*, *C. muesebecki*, *Bucerocolpocephalum emersoni*, and *B. deignani*. New synonymy is *C. acutovulvata* (Piaget, 1881) (=*C. njöbergi* (Eichler, 1947)). New type designations are: A neotype for *Chapinia hirta* (Rudow, 1866), a neotype for *Bucerophagus forcipatus* (Nitzsch, 1874), and a lectotype for *C. bucerotis* (Kellogg, 1908). Differential characters are listed for genera, species-groups, and species, and a key is provided for separating the species.

The amblyceran species-groups are confined to the Ethiopian region or to the Oriental and Australasian regions as shown in a table of the hornbill hosts, their distribution, and amblyceran parasites. *Tockus* is the only hornbill genus with amblyceran lice that is present in both the Ethiopian and Oriental regions; however, *Chapinia clayae* of the *acutovulvata* species-group from the Oriental species of *Tockus* resembles *C. acutovulvata* from Oriental species of *Anthracoceros* more closely than species of the *lophocerus* species-group from Ethiopian species of *Tockus*. It would appear, that there has been more recent contact between the Oriental species of *Tockus* and *Anthracoceros*, whose ranges overlap, than between the more closely related Oriental and Ethiopian species of *Tockus*.

Literature Cited

Bedford, G. A. H.

1920. Anoplura from south African hosts, pt. 2. Rept. Vet. Res. South Africa, vols. 7, 8, pp. 709–741, 7 pls.

1929. Anoplura (Siphunculata and Mallophaga) from south African hosts. Rept. Vet. Res. South Africa, vol. 15, pp. 501–549, 34 figs.

1930. New genera and species of Mallophaga from south African hosts. Rept. Vet. Res. South Africa, vol. 16, pp. 153–173, 16 figs.

Burmeister, C. H. C.

1838. Mallophaga. *In* Handbuch der Entomologie, vol. 2, pp. 418–443.

CLAY, THERESA

1947. A preliminary key to the genera of the Menoponidae (Mallophaga). Proc. Zool. Soc. London, vol. 117, pp. 457–477, 40 figs.

1949a. Systematic notes on the Piaget collections of Mallophaga, pt. 1. Ann. Mag. Nat. Hist. ser. 12, vol. 2, pp. 811–838, 895–921, 6 figs.

1949b. Some problems in the evolution of a group of ectoparasites. Evolution, vol. 3, pp. 279–299, 4 figs.

1951a. Systematic notes on the Piaget collections, pt. 2. Ann. Mag. Nat. Hist. ser. 12, vol. 4, pp. 173–182.

1951b. Systematic notes on the Piaget collections of Mallophaga, pt. 3. Ann. Mag. Nat. Hist. ser. 12, vol. 4, pp. 1159–1168, 15 figs., 1 pl.

1954. The postspiracular seta and sensillus in the Mallophaga (Insecta). Ann. Mag. Nat. Hist. ser. 12, vol. 7, pp. 716–718, 2 figs.

1955. A new genus of Ishnocera (Mallophaga). Proc. Roy. Ent. Soc. London (B), vol. 24, pp. 1–6, 7 figs., 1 pl.

1956. Phthiraptera. *In* Tuxen, Taxonomist's glossary of genitalia in insects, pp. 145–148, 4 figs.

1958. Revisions of Mallophaga genera: *Degeeriella* from the Falconiformes. Bull. British Mus. (Nat. Hist.) Ent., vol. 7, pp. 5–217, 164 figs., 9 pls.

1961. A new genus and species of Menoponidae (Mallophaga Insecta) from *Apteryx*. Ann. Mag. Nat. Hist. ser. 13, vol. 3, pp. 571–577, 12 figs., 1 pl.

1962. A key to the species of *Actornithophilus* Ferris with notes and descriptions of new species. Bull. British Mus. (Nat. Hist.) Ent., vol. 11, pp. 191–252, 72 figs., 8 pls.

CONCI, CESARE

1950. Mallophaga. Riv. Biol. Colon., vol. 10, pp. 77–82, 7 figs.

COPE, OLIVER B.

1941. The morphology of a species of the genus *Tetrophthalmus* (Mallophaga: Menoponidae). Microentomology, vol. 6, pp. 71–92, 10 figs.

DEIGNAN, H. G.

1963. Checklist of the birds of Thailand. U.S. Nat. Mus. Bull., vol. 226, pp. 1–263, 1 fig.

EICHLER, VON WOLFDIETRICH

1947. Dr. E. Mjöberg's zoological collections from Sumatra, 15: Mallophaga. Ark. Zool., vol., 39 A, pp. 1–21, 40 figs.

EMERSON, K. C.

1954. Review of the genus *Menopon* Nitzsch, 1818 (Mallophaga). Ann. Mag. Nat. Hist. ser. 12, vol. 7, pp. 225–232, 12 figs.

EMERSON, K. C., and WARD, RONALD A.

1958. Notes on the Philippine Mallophaga, 1: Species from Ciconiiformes, Anseriformes, Falconiformes, Galliformes, Gruiformes, and Charadriiformes (Philippine Zoological Expedition 1946–1947). Fieldiana, vol. 42, pp. 49–61, 4 figs.

EWING, H. E.

1927. Descriptions of new genera and species of Mallophaga together with keys to some related genera of Menoponidae and Philopteridae. Journ. Washington Acad. Sci., vol. 17, pp. 86–96.

FERRIS, G. F.

1923. The mallophagan family Menoponidae. Parasitology, vol. 16, pp. 55–65.

GIEBEL, C.
1866. Die im Zoologischen Museum der Universität Halle aufgestellten Epizoen nebst Beobachtungen über dieselben. Zeitschr. Ges. Naturwiss., vol. 28, pp. 353–397.
1874. Insecta Epizoa, 329 pp., 20 pls.
HARRISON, L.
1915. Mallophaga from *Apteryx* and their significance with a note on the genus *Rallicola*. Parasitology, vol. 8, pp. 88–100, 6 figs.
HOPKINS, G. H. E.
1941. Stray notes on Mallophaga, 15: Notes on the types of the Mallophaga described by Bedford. Ann. Mag. Nat. Hist. ser 11, vol. 7, pp. 274–294.
HOPKINS, G. H. E., and CLAY, THERESA
1952. A checklist of the genera and species of Mallophaga, 362 pp.
HOYLE, W. L.
1938. Transmission of poultry parasites. Trans. Kansas Acad. Sci., vol. 41, pp. 379–384.
JOHNSON, PHYLLIS T.
1960. The Anoplura of African Rodents and Insectivores. U.S. Dept. Agric. Tech. Bull., vol. 1211, pp. 1–116, 180 figs.
KELLOG, V. L.
1896. New Mallophaga, 1: With special reference to a collection made from maritime birds of the bay of Monterey, California. Proc. California Acad. Sci., vol. 6, pp. 31–182, 4 figs., 14 pls.
1908. Mallophaga. No. 4 *of* Corrodentia, no. 15 *in* Sjöstedt, Wissenschaftliche Ergebnisse der Schwedischen Zoologischen Expedition nach dem Kilimandjaro, dem Meru und den umgebenden Massaisteppen Deutsch-Ostafrikas, 1905–1906 . . ., pp. 43–58, 1 pl.
MACKWORTH-PRAED and GRANT, G. H. B.
1952. Birds of East and Northeast Africa, ser. 1 ,vol. 1, 836 pp.
NITZSCH, L.—*see* Giebel, 1874.
PETERS, J. L.
1945. Bucerotidae. *In* Checklist of birds of the world, vol. 5, pp. 254–272.
PIAGET, E.
1880. Les Pédiculines: Essai monographique, xxxix, + 714 pp., 56 pls.
1881. Quatre Nouvelles Pédiculines. Tijdschr. Ent., vol. 24, pp. 1–6, 1 pl.
1885. Les Pédiculines: Supplément, xii+201 pp., 17 pls.
1888. Quelques nouvelles Pédiculines. Tijdschr. Ent., vol. 31, pp. 147–166, 2 pls.
RUDOW, F.
1866. Charakteristik neuer Federlinge. Zeitschr. Ges. Naturwiss., vol. 27, pp. 465–477.
1869. Neue Mallophagen. Zeitschr. Ges. Naturwiss., vol. 34, pp. 387–407

TABLE 1.—*Measurements in mm. of* Chapinia *males* (from specimens from which drawings were made and from hosts, in parentheses, other than type hosts)

	Length		Width			
	Head	Total	Head	Prothorax	Metathorax	Abdomen
fasciati	0. 283	1. 655	0. 544	0. 391	0. 588	0. 788
lophocerus	. 276	1. 764	. 529	. 384	. 565	. 895
(*T. nasutus*)	. 304		. 551	. 398	. 558	
(*T. e. erythrorhynchus*)	. 290		. 536	. 362	. 522	
camuri	. 304	1. 302	. 485	. 370	. 464	. 732
bucerotis	. 304	2. 010	. 581	. 435	. 602	. 786
(*B. b. bucinator*)	. 304		. 565	. 413	. 588	
(*B. c. cylindricus*)	. 290		. 558	. 406	. 544	
(*B. c. albotibialis*)	. 286		. 544	. 398	. 540	
(*B. sc. subquadratus*)	. 290		. 572	. 413	. 551	
(*B. b. brevis*)	. 308		. 559	. 409	. 576	
robusta	. 348	2. 222	. 602	. 471	. 682	. 868
(*C. elata*)	. 326		. 595	. 450	. 652	
clayae	. 312	1. 600	. 544	. 370	. 551	. 760
wanili	. 355	2. 170	. 638	. 398	. 688	1. 000
acutovulvata	. 333	1. 818	. 616	. 427	. 652	. 840
(*A. coronatus*)	. 348		. 623	. 442	. 616	
malayensis	. 312	1. 655	. 602	. 478	. 630	. 950
hoplai	. 362	1. 845	. 572	. 442	. 623	. 868
boonsongi	. 355	1. 764	. 544	. 435	. 581	. 840
wenzeli	. 304	1. 410	. 529	. 391	. 551	. 705
(*P. p. manilloe*)	. 297		. 478	. 370	. 485	
(*P. p. mindorensis*)	. 304		. 478	. 362	. 492	
(*P. p. affinis*)	. 283		. 515	. 355	. 522	
blakei	. 333	1. 790	. 572	. 450	. 652	. 786
(*R. l. waldeni*)	. 355		. 544	. 420	. 572	
traylori	. 340	1. 980	. 609	. 492	. 689	. 868
(*B. h. mindanensis*)	. 312		. 595	. 464	. 630	
lydae	. 375	1. 850	. 531	. 437	. 625	. 825
muesebecki	. 333	1. 790	. 536	. 398	. 572	. 814
hirta	. 348	1. 710	. 529	. 427	. 609	. 868
(*R. p. mendanae*)	. 344		. 522	. 435	. 605	

TABLE 2.—*Measurements in mm. of* Chapinia *females* (from specimens from which drawings were made and from hosts, in parentheses, other than type hosts)

	Length		Width			
	Head	Total	Head	Prothorax	Metathorax	Abdomen
fasciati	0. 340	2. 222	0. 630	0. 485	0. 689	1. 004
(*T. alboterminatus*)	. 333		. 609	. 478	. 674	
lophocerus	. 304	2. 170	. 623	. 450	. 689	1. 085
(*T. nasutus*)	. 348		. 630	. 471	. 738	
(*T. e. erythrorhynchus*)	. 318		. 602	. 427	. 667	
camuri	. 333	1. 926	. 544	. 406	. 602	0. 950
bucerotis	. 362	2. 715	. 660	. 522	. 811	1. 112
(*B. b. bucinator*)	. 340		. 630	. 478	. 745	
(*B. c. cylindricus*)	. 326		. 630	. 478	. 745	
(*B. c. albotibialis*)	. 377		. 623	. 492	. 768	
(*B. sc. subquadratus*)	. 311		. 623	. 450	. 768	
robusta	. 362	2. 550	. 652	. 508	. 803	1. 112
(*C. elata*)	. 333		. 630	. 485	. 775	
clayae	. 326	2. 118	. 602	. 435	. 717	1. 085
vaniti	. 390	2. 550	. 720	. 496	. 822	1. 190
acutorulvata	. 406	2. 550	. 703	. 492	. 782	1. 250
(*A. coronatus*)	. 362		. 717	. 529	. 761	
malayensis	. 333	2. 010	. 652	. 515	. 789	1. 085
hoplai	. 333	2. 280	. 595	. 464	. 745	0. 976
boonsongi	. 376	2. 150	. 563	. 469	. 719	1. 006
wenzeli	. 311	1. 980	. 581	. 450	. 660	1. 004
(*P. p. manilloe*)	. 333		. 551	. 435	. 660	
(*P. p. affinis*)	. 304		. 581	. 420	. 696	
blakei	. 362	2. 010	. 595	. 485	. 689	0. 976
(*R. l. waldeni*)	. 355		. 599	. 486	. 711	
traylori	. 333	2. 770	. 606	. 551	. 861	1. 194
(*B. h. mindanensis*)	. 318		. 667	. 544	. 854	
lydae	. 375	2. 155	. 544	. 482	. 712	1. 006
hirta	. 377.	2. 035	. 551	. 464	. 674	0. 976
(*R. p. subruficollis*)	. 348		. 565	. 427	. 667	

TABLE 3.—*Measurements in mm. of* Bucerocolpocephalum (from specimens from which drawings were made and from hosts, in parentheses, other than type hosts)

Male	Length		Width			
	Head	Total	Head	Prothorax	Metathorax	Abdomen
emersoni	0.304	1.954	0.435	0.384	0.471	0.548
(*P. t. indochinensis*)	.318		.435	.398	.485	
deignani	.312	1.800	.437	.362	.444	.581
(*A. g. carinatus*)	.304		.464	.398	.471	
Female						
emersoni	.318	2.010	.450	.406	.544	.786
(*P. t. indochinensis*)	.300		.442	.399	.519	
deignani	.318	1.960	.481	.418	.531	.800

TABLE 4.—*Measurements in mm. and computations for* Bucerophagus proceus *males on host 1,* Bucorvus abyssinicus (see p. 45 for explanation of formulae)

	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=8	0.350	0.507	0.436	0.586	0.707	1.914
	.371	.5285	.457	.586	.771	2.071
	.371	.514	.457	.586	.714	1.914
	.386	.5285	.464	.543	.771	2.0785
	.436	.550	.464	.543	.750	2.0785
	.486	.550	.486	.5785	.750	2.100
	.400	.514	.414	.571	.721	2.114
	.400	.507	.414	.571	.7285	2.057
$Sx_1=$	3.200	4.199	3.592	4.5645	5.9125	16.327
$\bar{x}_1=$	0.400	0.525	0.449	0.5705	0.739	2.041
$Sx_1^2=$	1.293	2.206	1.617	2.607	4.374	33.366
$(Sx_1)^2=$	10.240	17.632	12.902	20.835	34.958	266.571
$(Sx_1)^2/N=$	1.280	2.204	1.613	2.604	4.370	33.321
$S(x-\bar{x}_1)^2=$	0.0130	0.0020	0.0040	0.0030	0.0040	0.0450
$s_1^2=$	.00186	.000286	.000571	.000428	.000571	.00643

TABLE 5.—*Measurements in mm. and computations for* Bucerophagus productus *males on host 2,* Bucorvus leadbeateri (see p. 45 for explanation of formulae)

	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=28	0.414	0.521	0.443	0.521	0.7285	1.750
	.414	.521	.443	.521	.7285	1.700
	.414	.521	.443	.521	.7285	1.743
	.414	.5285	.443	.471	.7285	1.743
	.414	.5285	.443	.5285	.7285	1.714
	.414	.5285	.443	.5285	.686	1.850
	.414	.5285	.443	.5285	.707	1.929
	.414	.5285	.457	.5285	.707	2.029
	.414	.5285	.457	.5285	.707	1.700
	.414	.5285	.457	.557	.764	1.807
	.400	.5285	.457	.557	.764	1.821
	.400	.536	.457	.557	.714	1.979
	.400	.536	.457	.557	.714	2.136
	.386	.536	.457	.557	.736	2.129
	.386	.536	.457	.557	.743	2.271
	.3785	.536	.457	.514	.771	2.171
	.393	.514	.421	.543	.757	1.857
	.407	.514	.450	.543	.757	1.857
	.4285	.550	.450	.543	.786	2.243
	.4285	.550	.450	.543	.786	1.579
	.4285	.550	.436	.564	.800	2.021
	.4285	.543	.436	.564	.750	1.964
	.443	.543	.471	.536	.750	2.079
	.443	.543	.471	.536	.750	1.900
	.421	.543	.471	.536	.750	1.900
	.457	.557	.464	.500	.814	1.814
	.371	.500	.464	.550	.821	1.786
	.3285	.500	.414	.571	.700	1.914
$Sx_2=$	11.468	14.878	12.612	15.0615	20.8765	53.386
$\bar{x}_2=$	0.4095	0.531	0.450	0.538	0.746	1.907
$Sx_2^2=$	4.714	7.911	5.686	8.114	15.597	102.629
$(Sx_2)^2=$	131.515	221.355	159.063	226.849	435.828	2850.065
$(Sx_2)^2/N=$	4.697	7.906	5.681	8.102	15.565	101.788
$S(x-\bar{x}_2)^2=$	0.0170	0.0050	0.0050	0.0120	0.0320	0.841
$s_2^2=$	.00060	.000180	.000180	.000444	.001185	.0311

TABLE 6.—*Measurements in mm. and computations for* Bucerophagus productus *females on host 1,* Bucorvus abyssinicus (see p. 45 for explanation of formulae)

	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=8	0.464	0.636	0.536	0.714	1.036	3.250
	.443	.614	.5285	.714	1.050	3.171
	.507	.650	.543	.686	1.043	2.607
	.443	.657	.543	.686	1.136	2.736
	.4785	.657	.543	.6785	1.143	3.100
	.493	.657	.543	.6785	1.193	3.114
	.500	.671	.543	.6785	1.100	2.621
	.457	.614	.543	.693	1.0785	3.171
$Sx_1=$	3.7855	5.156	4.3225	5.5285	8.7795	23.770
$\bar{x}_1=$	0.473	0.6445	0.540	0.691	1.097	2.971
$Sx_1^2=$	1.795	3.326	2.336	3.822	9.657	71.132
$(Sx_1)^2=$	14.330	26.584	18.684	30.564	77.080	565.013
$(Sx_1)^2/N=$	1.791	3.323	2.3355	3.820	9.635	70.627
$S(x-\bar{x}_1)^2=$	0.0050	0.0030	0.00050	0.0020	0.0220	0.505
$s_1^2=$	.000714	.000428	.0000714	.000286	.00714	.0721

TABLE 7.—*Measurements in mm. and computations for* Bucerophagus productus (see p. 45 for explanation of formulae)

Females on host 2, *Bucorvus leadbeateri*	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=34	0.471	0.600	0.500	0.621	0.914	2.843
	.471	.600	.500	.621	.914	2.900
	.471	.600	.500	.636	.957	3.229
	.500	.600	.500	.636	.957	3.229
	.500	.600	.500	.636	.957	2.793
	.500	.600	.500	.636	.971	3.164
	.500	.614	.529	.671	.971	3.200
	.500	.614	.529	.671	.979	3.250
	.500	.614	.529	.671	.979	2.957
	.500	.614	.529	.671	.986	2.521
	.500	.614	.529	.671	.986	2.500
	.500	.614	.529	.671	.986	3.057
	.500	.571	.529	.600	.986	3.136
	.500	.607	.486	.600	1.007	2.288
	.514	.607	.486	.614	0.893	3.086
	.514	.607	.493	.614	.900	2.229
	.486	.607	.479	.614	.900	3.171
	.486	.593	.479	.614	.886	2.971
	.486	.593	.521	.657	.857	2.729
	.486	.621	.521	.657	1.086	2.914
	.486	.621	.521	.657	1.029	2.771
	.486	.621	.521	.657	0.964	3.264
	.486	.621	.514	.657	1.014	2.900
	.464	.621	.514	.643	1.036	2.857
	.464	.621	.514	.643	1.036	2.857
	.457	.579	.514	.643	0.907	2.607
	.457	.629	.507	.629	.950	2.521
	.493	.629	.507	.607	.921	2.650
	.493	.629	.543	.607	1.100	3.257
	.529	.629	.543	.593	1.021	3.300
	.529	.629	.543	.686	1.071	3.093
	.529	.629	.536	.686	1.057	3.379
	.479	.650	.536	.664	1.079	3.007
	.479	.636	.536	.664	1.043	2.521
$Sx_1=$	16.716	20.834	17.517	21.818	33.300	99.840
$\bar{x}_1=$	0.492	0.613	0.515	0.642	0.979	2.937
$Sx_1^2=$	8.230	12.775	9.036	14.024	32.745	29.602
$(Sx_1)^2=$	279.425	434.056	306.845	476.025	1108.890	9969.632
$(Sx_1)^2/N=$	8.218	12.766	9.025	14.001	32.614	29.323
$S(x-\bar{x}_1)^2=$	0.0120	0.0090	0.0110	0.023	0.131	0.279
$s_0^2=$	.000364	.000273	.000330	.000697	.00397	.0085
Males on two hosts						
SE=	.0070	.00317	.00374	.00490	.00762	.0081
D=	.0095	.006	.001	.0325	.007	.134
CL=		.006±.0064		.0325±.010	.007±.015	
Females on two hosts						
SE=	.00447	.00374	.00436	.00538	.0135	0.0091
D=	.019	.031	.025	.049	.095	.024
CL=	.019±.009	.031±.0076		.049±.011	.095±.027	

TABLE 8.—*Measurements in mm. and computations for* Bucerophagus africanus *males on host 1,* Bucorvus abyssinicus (see p. 47 for explanation of formulae)

	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=3	0.457	0.628	0.528	0.693	0.957	2.528
	.471	.593	.507	.678	1.057	2.500
	.493	.586	.500	.728	1.050	2.557
$Sx_1=$	1.421	1.807	1.535	2.099	3.064	7.585
$\bar{x}_1=$	0.474	0.602	0.512	0.700	1.021	2.528
$Sx_1^2=$	0.674	1.089	0.786	1.470	3.136	19.179
$(Sx_1)^2=$	2.019	3.265	2.356	4.406	9.388	57.532
$(Sx_1)^2/N=$	0.673	1.088	0.785	1.468	3.129	19.177
$S(x-\bar{x}_1)^2=$	0.0010	0.0010	0.0010	0.0020	0.0070	0.0020
$s_1^2=$	0.00050	0.00050	0.00050	0.0010	0.00350	0.0010

TABLE 9.—*Measurements in mm. and computations for* Bucerophagus africanus *males on host 2,* Bucorvus leadbeateri (see p. 47 for explanation of formulae)

	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=6	0.393	0.557	0.500	0.650	0.943	2.371
	.400	.557	.500	.650	1.028	2.478
	.400	.586	.500	.650	0.971	2.428
	.443	.571	.485	.686	1.043	2.443
	.457	.586	.514	.686	1.050	2.486
	.371	.564	.521	.671	1.064	2.386
$Sx_2=$	2.464	3.421	3.020	3.993	6.099	14.592
$\bar{x}_2=$	0.411	0.570	0.503	0.666	1.016	2.432
$Sx_2^2=$	1.017	1.951	1.521	2.659	6.211	35.499
$(Sx_2)^2=$	6.071	11.703	9.120	15.944	37.198	212.926
$(Sx_2)^2/N=$	1.0120	1.950	1.520	2.657	6.200	35.488
$S(x-\bar{x}_2)^2=$	0.0050	0.0010	0.0010	0.0020	0.0110	0.0110
$s_2^2=$	0.0010	0.00020	0.00020	0.00040	0.00220	0.00220

TABLE 10.—*Measurements in mm. and computations for* Bucerophagus africanus *females on host 1,* Bucorvus abyssinicus (see p. 47 for explanation of formulae)

	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=4	0.493	0.664	0.564	0.728	1.214	3.300
	.514	.628	.543	.693	1.236	3.271
	.443	.628	.543	.786	1.300	3.428
	.486	.643	.586	.714	1.110	2.700
$Sx_1=$	1.936	2.563	2.236	2.921	4.860	12.699
$\bar{x}_1=$	0.484	0.641	0.559	0.730	1.215	3.175
$Sx_1^2=$	0.940	1.643	1.251	2.138	5.924	40.631
$(Sx_1)^2=$	3.748	6.569	5.000	8.532	23.620	161.265
$(Sx_1)^2/N=$	0.937	1.642	1.250	2.133	5.905	40.316
$S(x-\bar{x}_1)^2=$	0.0030	0.0010	0.0010	0.0050	0.0190	0.315
$s_1^2=$	0.0010	0.000333	0.000333	0.00166	0.00633	0.104

TABLE 11.—*Measurements in mm. and computations for* Bucerophagus africanus (see p.47 for explanation of formulae)

Females on host 2, *Bucorvus leadbeateri*	Head		Width			Total length
	Length	Width	Prothorax	Metathorax	Abdomen	
N=4	0.471	0.621	0.557	0.714	1.328	3.243
	.457	.593	.557	.678	1.143	3.000
	.457	.636	.514	.764	1.393	3.221
	.471	.628	.536	.743	1.321	3.386
Sx_1=	1.856	2.478	2.164	2.899	5.185	12.969
$\bar{x}_1$=	0.464	0.620	0.541	0.725	1.296	3.226
Sx_1^2=	0.861	1.536	1.172	2.105	6.756	42.011
$(Sx_1)^2$=	3.445	6.140	4.683	8.404	26.884	167.702
$(Sx_1)^2/N$=	0.861	1.535	1.171	2.101	6.721	41.926
$S(x-\bar{x}_1)^2$=	0.000	0.0010	0.0010	0.0040	0.0350	0.0850
$s_{\bar{x}}^2$=	0.000	0.000333	0.000333	0.00133	0.0117	0.0283
Males on two hosts						
SE=	.0138	.00797	.00797	.0127	.0239	.0203
D=	.063	.032	.009	.034	.005	.096
CL=	.063±.033	.032±.019	.009±.019	.034±.030	.005±.056	.096±.081
Females on two hosts						
SE=	.0112	.00913	.00913	.0194	.0478	.1290
D=	.020	.021	.018	.005	.081	.063
CL=	.020±.027	.021±.022	.018±.022	.005±.047	.081±.116	.063±.318

TABLE 12.—*Measurements in mm. of* Bucerophagus (from specimens from which drawings were made and from hosts, in parentheses, other than those from which drawings were made)

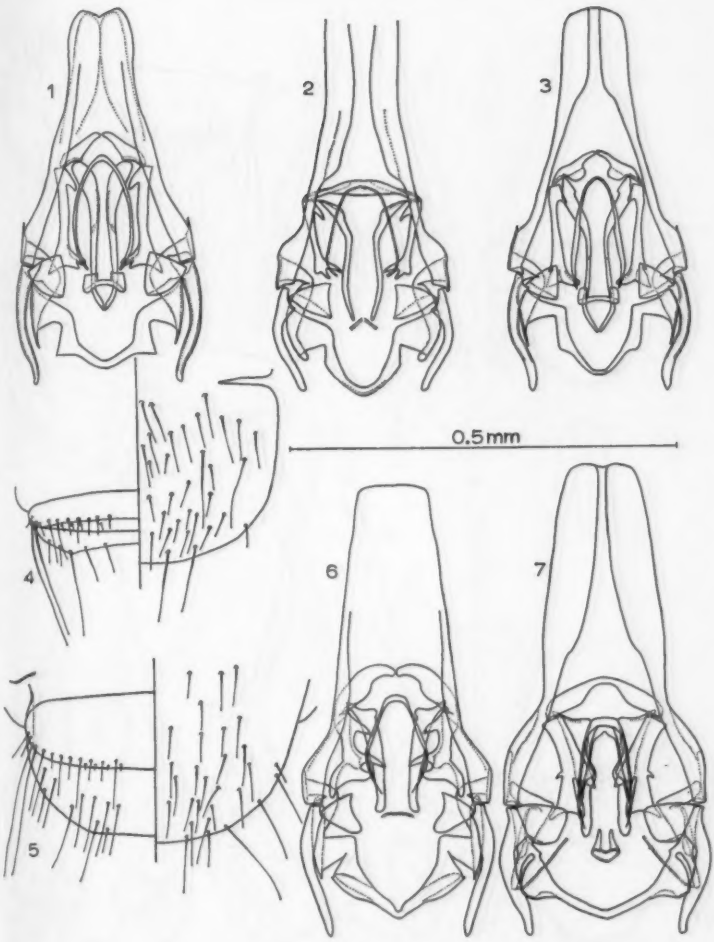
Male	Length		Width			
	Head	Total	Head	Prothorax	Metathorax	Abdomen
forcipatus	0.318	1.725	0.492	0.413	0.565	0.625
(*B. r. sumatranus*)	.322		.522	.438	.570	
(*B. r. borneoensis*)	.351		.515	.431	.652	
productus	.386	2.080	.528	.464	.578	.750
africanus	.457	2.488	.586	.500	.686	1.050
Female						
forcipatus	.370	1.125	.544	.435	.667	0.950
(*B. r. sumatranus*)	.355		.584	.464	.677	
(*B. r. borneoensis*)	.344		.580	.467	.678	
productus	.464	3.172	.636	.536	.714	1.035
africanus	.471	3.325	.636	.557	.764	1.390

TABLE 13.—*Bucerotidae arranged phylogenetically (Peters, 1945) with geographical distribution and amblyceran parasites* (blank indicates no lice found on host)

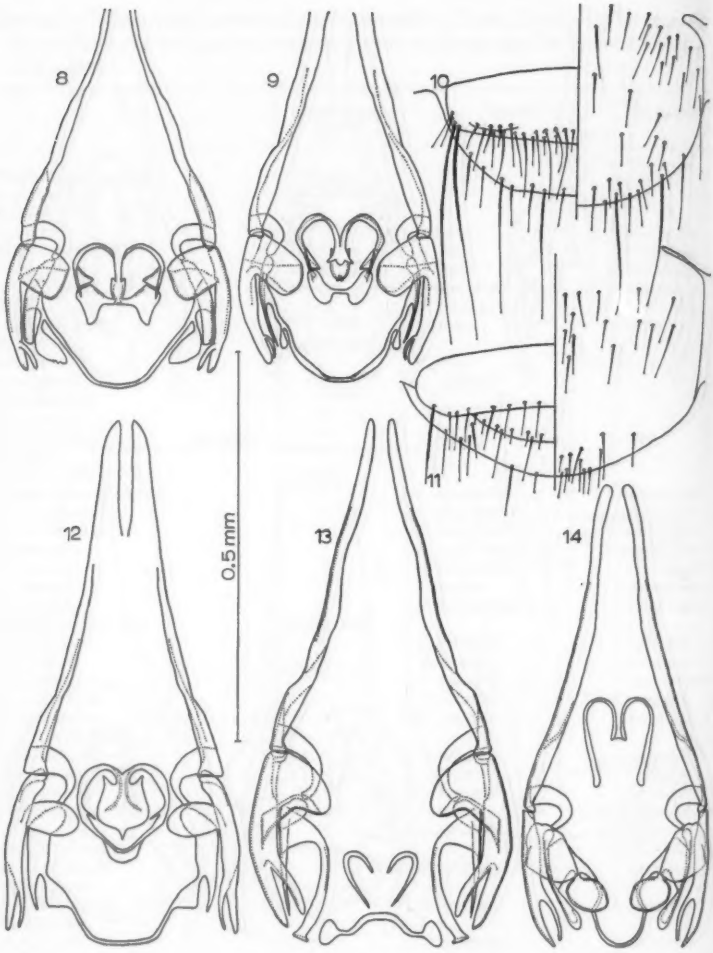
Host	Geographical region	Parasite	Species-group
Tockus birostris	Oriental	*Chapinia clayae*	*acutovulvata*
T. f. semifasciatus	Ethiopian		
T. f. fasciatus	"	*C. fasciati*	*lophocerus*
T. albaterminatus gelocensis	"		
T. a. stegmanni	"		
T. a. zuluensis	"	*C. fasciati*	*lophocerus*
T. a. angolensis	"		
T. a. albaterminatus	"		
T. a. australis	"		
T. b. bradfieldi	"		
T. b. williaminae	"		
T. p. pallidirostris	"		
T. p. neumanni	"		
T. n. nasutus	"	*C. lophocerus*	*lophocerus*
T. n. forskålii	"		
T. n. caffer	"	*C. lophocerus*	*lophocerus*
T. h. hemprichii	"		
T. h. ezul	"		
T. monteiri marjoriae	"		
T. m. monteiri	"		
T. g. griseus	Oriental	*C. clayae*	*acutovulvata*
T. g. gingalensis	"		
T. h. hartlaubi	Ethiopian		
T. h. granti	"		
T. c. pulchrirostris	"		
T. c. camurus	"	*C. camuri*	*lophocerus*
T. c. erythrorhynchus	"	*C. lophocerus*	*lophocerus*
T. c. rufirostris	"		
T. c. damarensis	"		
T. c. ngamiensis	"		
T. f. flavirostris	"	*C. lophocerus*	*lophocerus*
T. f. somaliensis	"		
T. f. leucomelas	"	*C. lophocerus*	*lophocerus*
T. f. elegans	"		
T. deckeni	"	*C. lophocerus*	*lophocerus*
Bernicornis comatus	Oriental		
B. a. albo-cristatus	Ethiopian		
B. a. macrourus	"		
B. a. cassini	"		
Ptilolaemus t. austeni	Oriental	*Bucerocolpocephalum emersoni*	
P. t. tickelli	"		
P. t. indochinensis	"	*B. emersoni*	
Anorrhinus g. carinatus	"	*C. wantii* and *B. deignani*	*acutovulvata*
A. g. galeritus	"	*B. deignani*	
A. g. minor	"		
Penelopides p. manilloe	"	*C. wenzeli*	*acutovulvata*
P. p. subnigra	"		
P. p. mindorensis		*C. wenzeli*	*acutovulvata*
P. p. ticaensis	"		
P. p. panini			
P. p. samarensis	"	*C. wenzeli*	*acutovulvata*
P. p. affinis	"	*C. wenzeli*	*acutovulvata*
P. p. basilanica	"		
P. c. czarhatus	Australasian	*C. muesebecki*	*hirta*
P. c. sanfordi	"		

TABLE 13.—*Bucerotidae arranged phylogenetically (Peters, 1945) with geographical distribution and amblyceran parasites* (blank indicates no lice found on host)—Continued

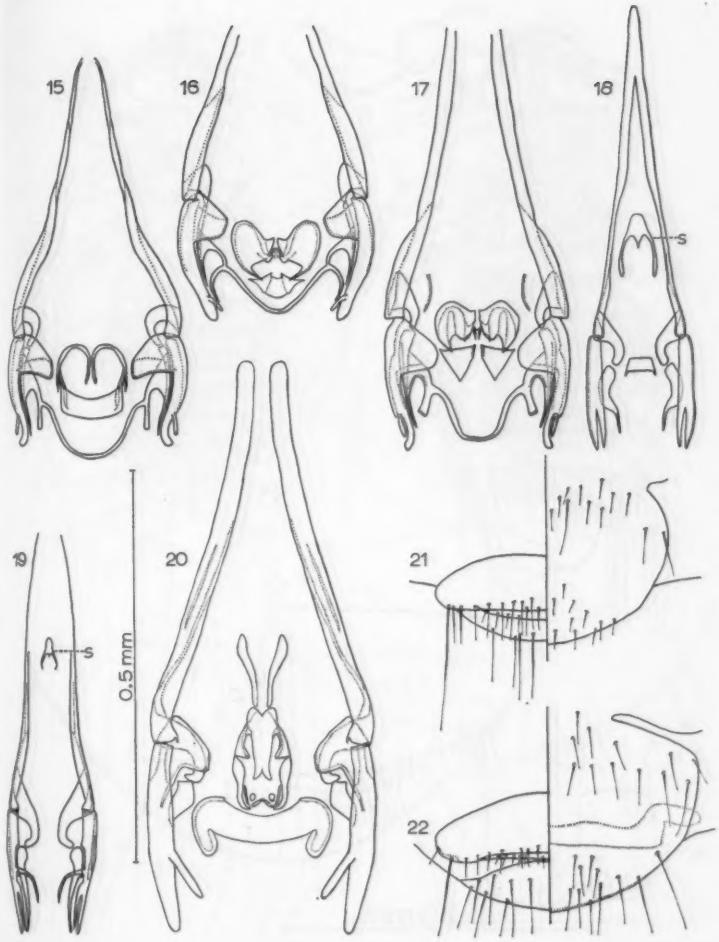
Host	Geographical region	Parasite	Species-group
Rhyticeros nipalensis	Oriental		
R. c. corrugatus	"		
R. c. megistus	"		
R. l. waldeni	"	*C. blakei*	*acutovulvata*
R. l. leucocephalus	"	*C. blakei*	*acutovulvata*
R. cassidix	Australasian	*C. lydae*	*acutovulvata*
R. u. ticehursti	Oriental	*C. boonsongi*	*acutovulvata*
R. u. undulatus	"	*C. boonsongi*	*acutovulvata*
R. p. subruficollis	"	*C. hirta*	*hirta*
R. p. plicatus	Australasian		
R. p. ruficollis	"	*C. hirta*	*hirta*
R. p. fungei	"		
R. p. dampieri	"		
R. p. harterti	"		
R. p. mendanae	"	*C. hirta*	*hirta*
R. everetti	"		
R. narcondami	Oriental		
Anthracoceros malayanus	"	*C. malayensis*	*acutovulvata*
A. a. albirostris	"	*C. acutovulvata*	*acutovulvata*
A. a. leucogaster	"	*C. acutovulvata*	*acutovulvata*
A. coronatus	"	*C. acutovulvata*	*acutovulvata*
A. convexus	"	*C. acutovulvata*	*acutovulvata*
A. montani	"	*C. hopkai*	*acutovulvata*
A. marchei	"	*C. acutovulvata*	*acutovulvata*
Bycanistes b. fistulator	Ethiopian		
B. b. sharpii	"	*C. bucerotis*	*lophocerus*
B. b. duboisi	"	*C. bucerotis*	*lophocerus*
B. b. bucinator	"	*C. bucerotis*	*lophocerus*
B. c. cylindricus	"	*C. bucerotis*	*lophocerus*
B. c. albotibialis	"	*C. bucerotis*	*lophocerus*
B. s. subcylindricus	"		
B. s. subquadratus	"	*C. bucerotis*	*lophocerus*
B. b. omissus	"	*C. bucerotis*	*lophocerus*
B. b. brevis	"	*C. bucerotis*	*lophocerus*
Ceratogymna atrata	"	*C. robusta*	*lophocerus*
C. elata	"	*C. robusta*	*lophocerus*
Buceros r. rhinoceros	Oriental		
B. r. sumatranus	"	*Bucerophagus forcipatus*	*forcipatus*
B. r. silvestris	"		
B. r. borneoensis	"	*B. forcipatus*	*forcipatus*
B. b. bicornis	"		
B. b. homrai	"	*B. forcipatus*	*forcipatus*
B. h. hydrocorax	"		
B. h. semigaleatus	"	*C. traylori*	*acutovulvata*
B. h. mindanensis	"	*C. traylori*	*acutovulvata*
B. h. basilanicus			
Rhinoplax vigil	"	*Bucerophagus forcipatus*	*forcipatus*
Bucorvus abyssinicus	Ethiopian	*B. productus* and *B. africanus*	*productus* *productus*
B. leadbeateri	"	*B. africanus* and *B. productus*	*productus* *productus*



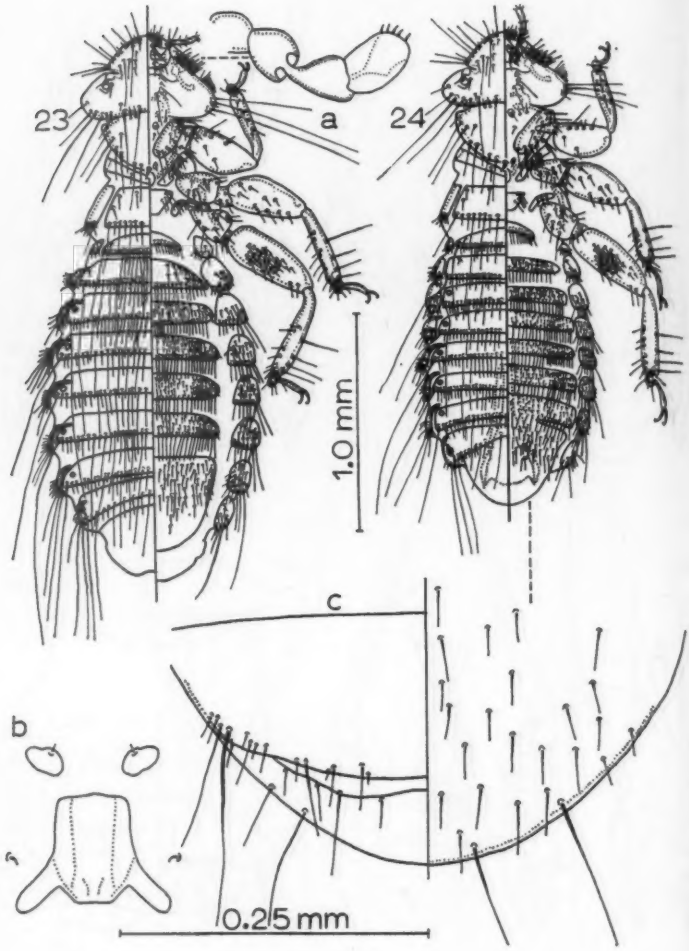
FIGURES 1–7.—The *lophocerus* species-group. Male genitalia, ventral view: 1, *Chapinia fasciati*, new species, holotype; 2, *C. lophocerus* (Bedford), lectotype; 3, *C. camuri*, new species, holotype; 6, *C. bucerotis* (Kellogg), lectotype; 7, *C. robusta* Ewing. Male terminal abdominal segments, dorsal-ventral view: 4, *C. lophocerus* (Bedford), lectotype; 5, *C. bucerotis* (Kellogg), lectotype.



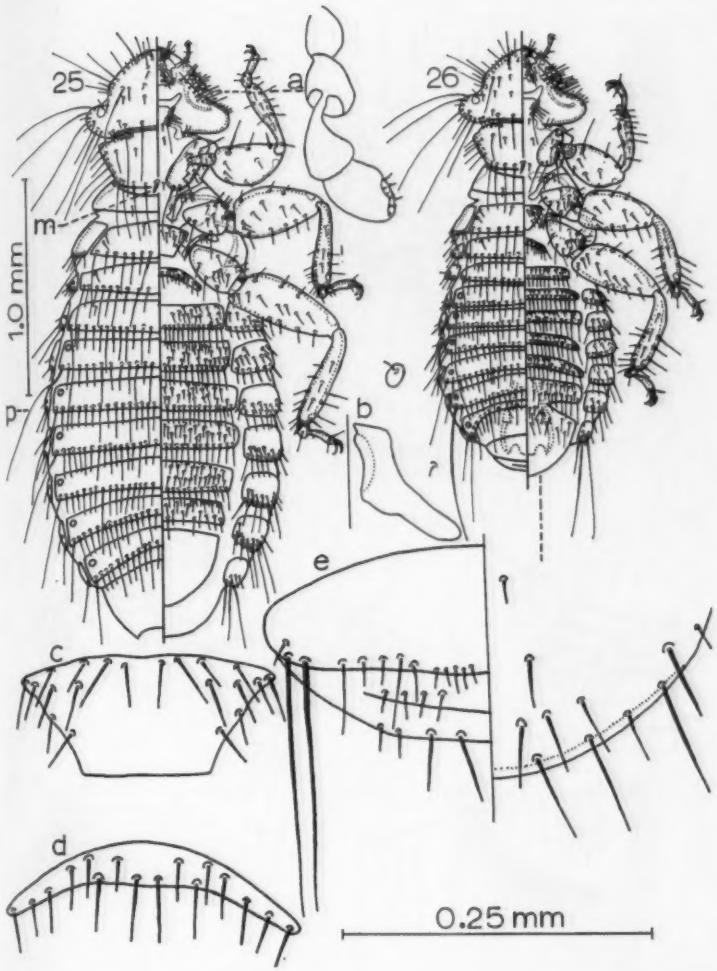
FIGURES 8–14.—The *acutovulvata* species-group. Male genitalia, ventral view: 8, *Chapinia clayae*, new species, holotype; 9, *C. acutovulvata* (Piaget); 12, *C. malayensis*, new species, holotype; 13, *C. hoplai*, new species, holotype; 14, *C. boonsongi*, new species, holotype. Male terminal abdominal segments, dorsal-ventral view: 10, *C. acutovulvata* (Piaget); 11, *C. boonsongi*, new species, holotype.



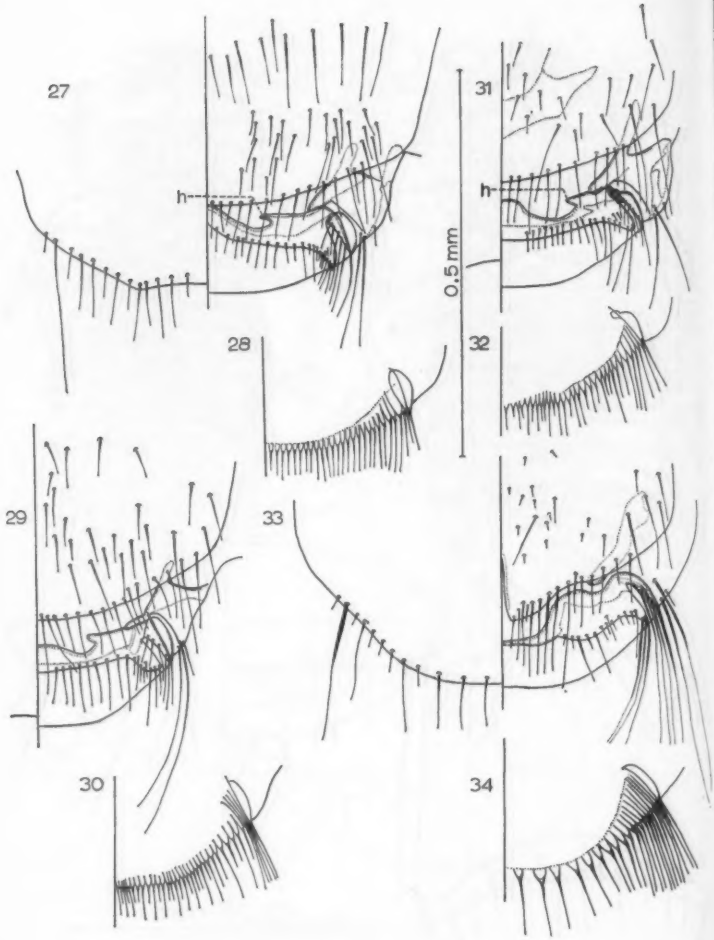
FIGURES 15–22.—The *acutovulvata* and *hirta* species-groups. Male genitalia, ventral view: 15, *Chapinia wenzeli*, new species, holotype; 16, *C. blakei*, new species, holotype; 17, *C. traylori*, new species, holotype; 18, *C. muesebecki*, new species, holotype; 19, *C. hirta* (Rudow), neotype; 20, *C. lydae*, new species, holotype. Male terminal abdominal segments, dorsal-ventral view: 21, *C. muesebecki*, new species, holotype; 22, *C. hirta* (Rudow), neotype. (s=sclerite of genital sac.)



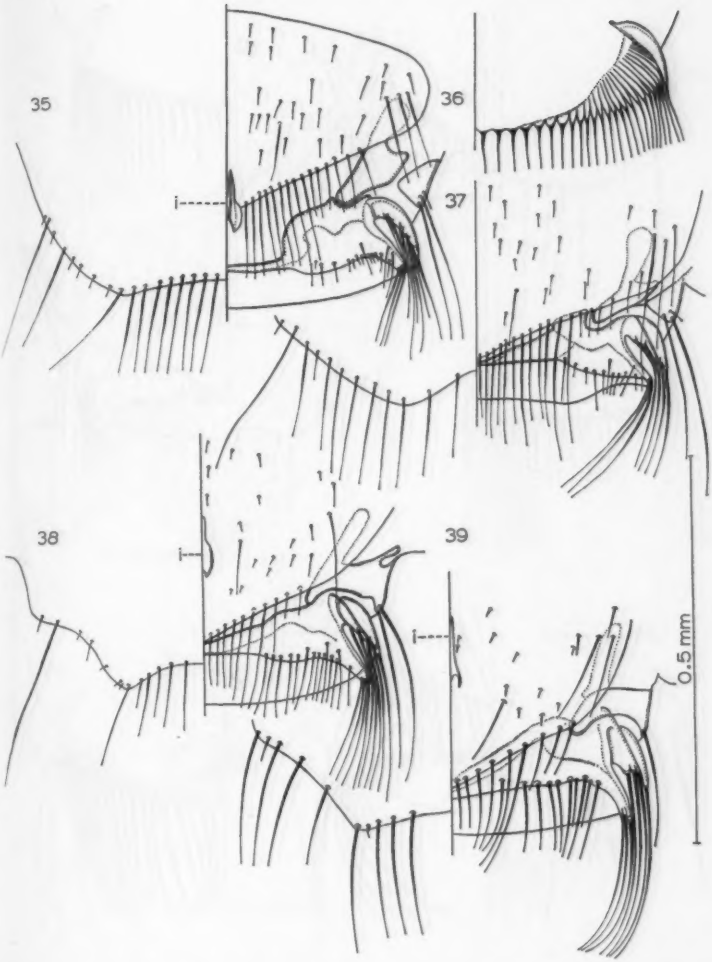
FIGURES 23, 24.—*Chapinia robusta* Ewing, dorsal-ventral view: 23, female; 24, male. (a=antenna of female; b=prosternal plate of female; c=terminal abdominal segments of male.)



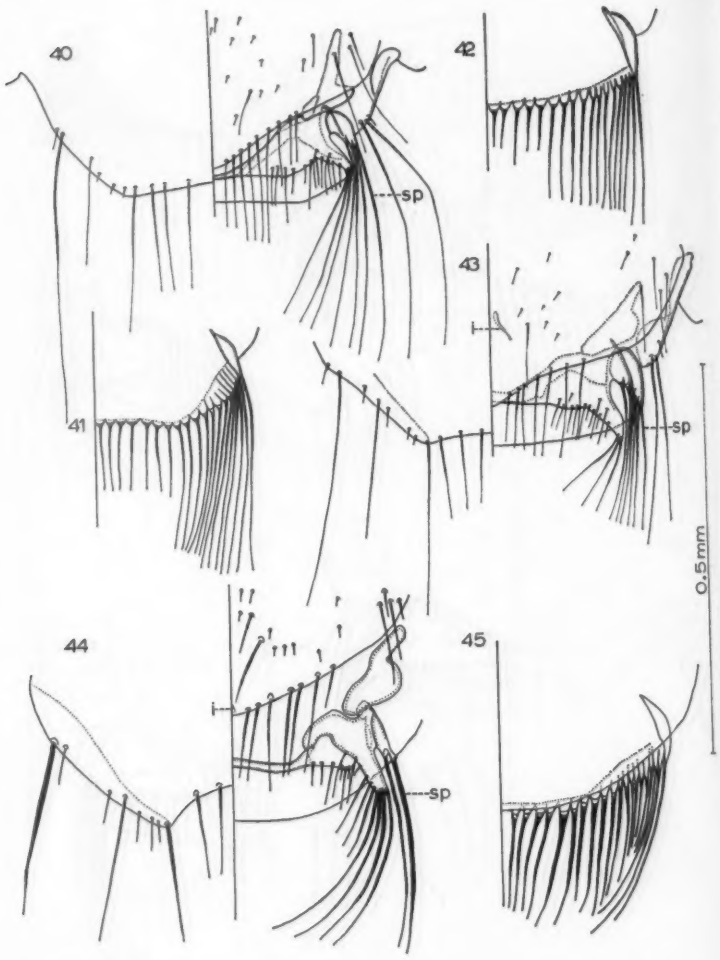
FIGURES 25, 26.—*Chapinia traylori*, new species, dorsal-ventral view: 25, allotype female; 26, holotype male. (a=antenna of female; b=prosternal plate of female; c=metasternal plate of male; d=first abdominal sternite of male; e=terminal abdominal segments of male; m=mesonotum; p=postspiracular seta.)



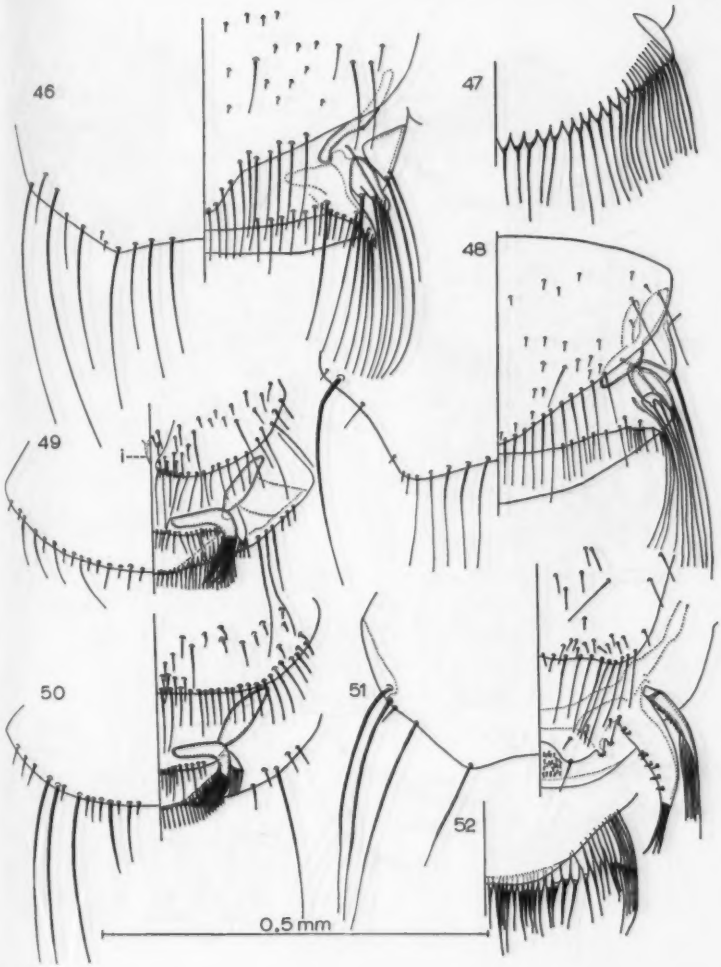
FIGURES 27–34.—The *lophocerus* and *acutovulvata* species-groups. Female terminal abdominal segments, dorsal-ventral view: 27, *Chapinia lophocerus* (Bedford); 29, *C. bucerotis* (Kellogg); 31, *C. robusta* Ewing; 33, *C. clayae*, new species, allotype. Female anal fringes, ventral view: 28, *C. lophocerus* (Bedford); 30, *C. bucerotis* (Kellogg); 32, *C. robusta* Ewing; 34, *C. clayae*, new species, allotype. (h=sclerital hooks.)



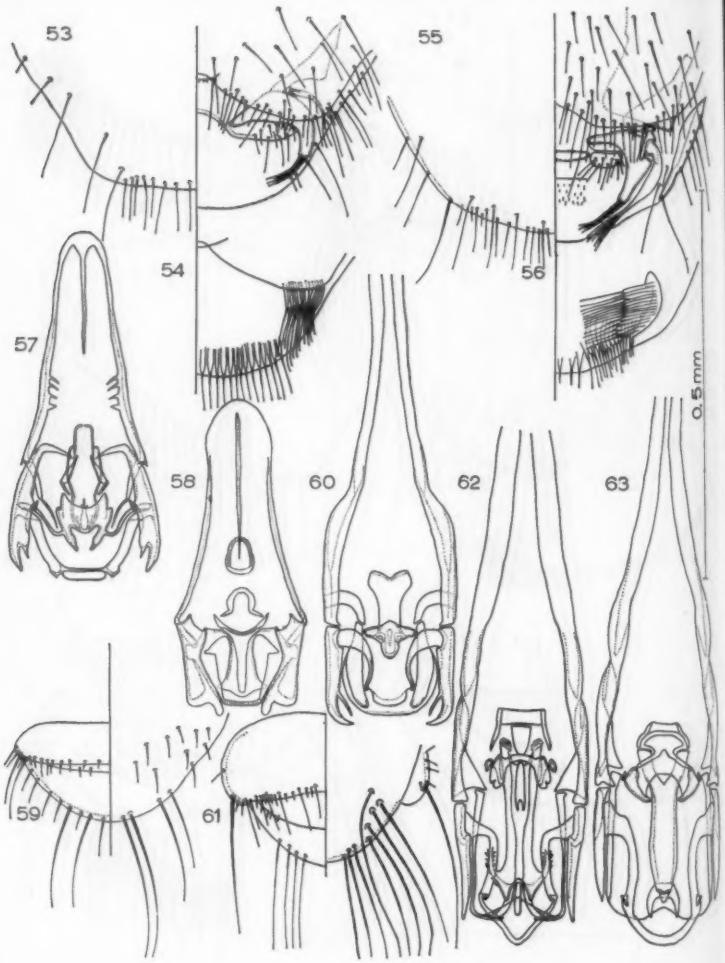
FIGURES 35–39.—The *acutovulvata* species-group. Female terminal abdominal segments, dorsal-ventral view: 35, *Chapinia acutovulvata* (Piaget); 37, *C. malayensis*, new species, allotype; 38, *C. hoplai*, new species, allotype; 39, *C. boonsongi*, new species, allotype. Female anal fringes, ventral view: 36, *C. acutovulvata* (Piaget). (i=internal sclerite of abdominal sternite VIII.)



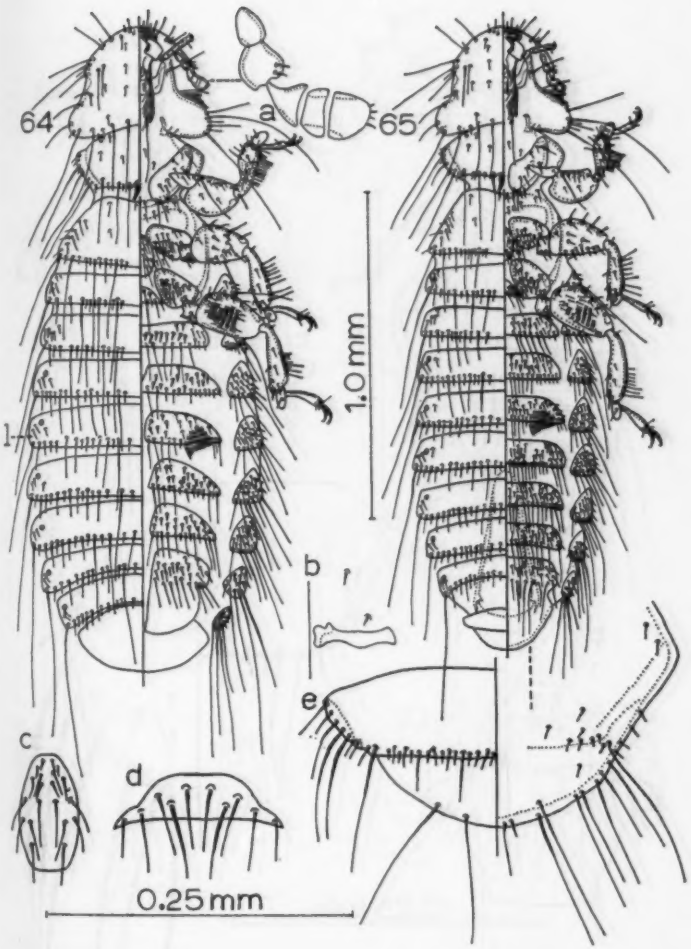
FIGURES 40–45.—The *acutovulvata* species-group. Female terminal abdominal segments, dorsal-ventral view: 40, *Chapinia wenzeli*, new species, allotype; 43, *C. blakei*, new species, allotype; 44, *C. traylori*, new species, allotype. Female anal fringes, ventral view: 41, *C. wenzeli*, new species, allotype; 42, *C. blakei*, new species, allotype; 45, *C. traylori*, new species, allotype. (i=internal sclerite of abdominal sternite VIII; sp=posteriorly directed setae on lateral projection of ventral sclerite between vulva and anus.)



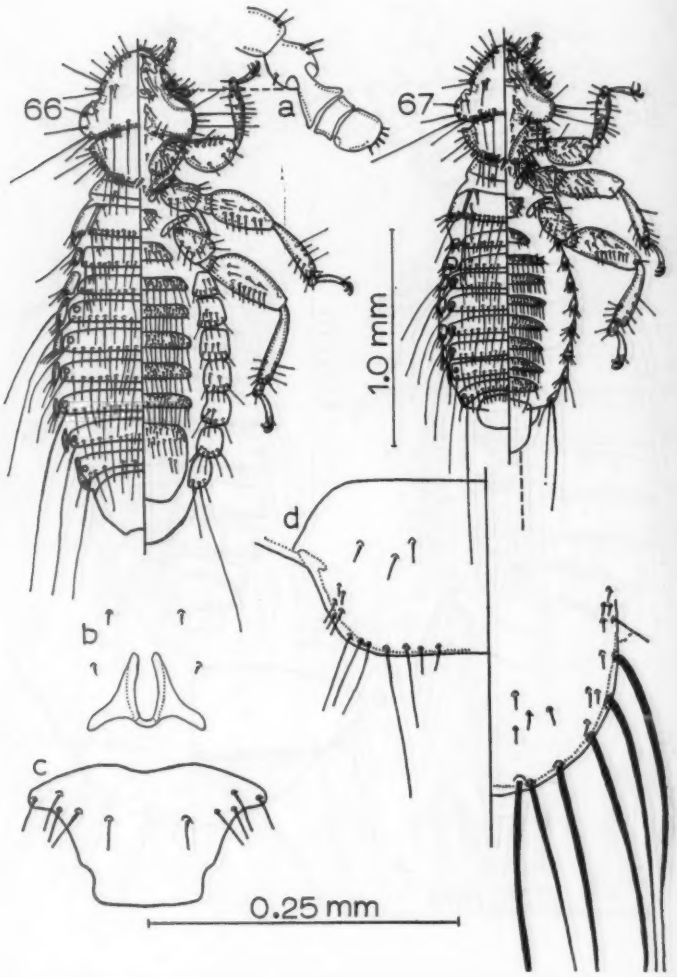
FIGURES 46–52.—Female terminal abdominal segments, dorsal-ventral view: 46, *Chapinia lydae*, new species, allotype; 48, *C. hirta* (Rudow); 49, *Bucerocolpocephalum emersoni*, new species, allotype; 50, *B. deignani*, new species, allotype; 51, *Bucerophagus forcipatus* (Nitzsch). Female anal fringes, ventral view: 47, *C. hirta* (Rudow); 52, *Bucerophagus forcipatus* (Nitzsch). (i=internal sclerite of abdominal sternite VIII.)



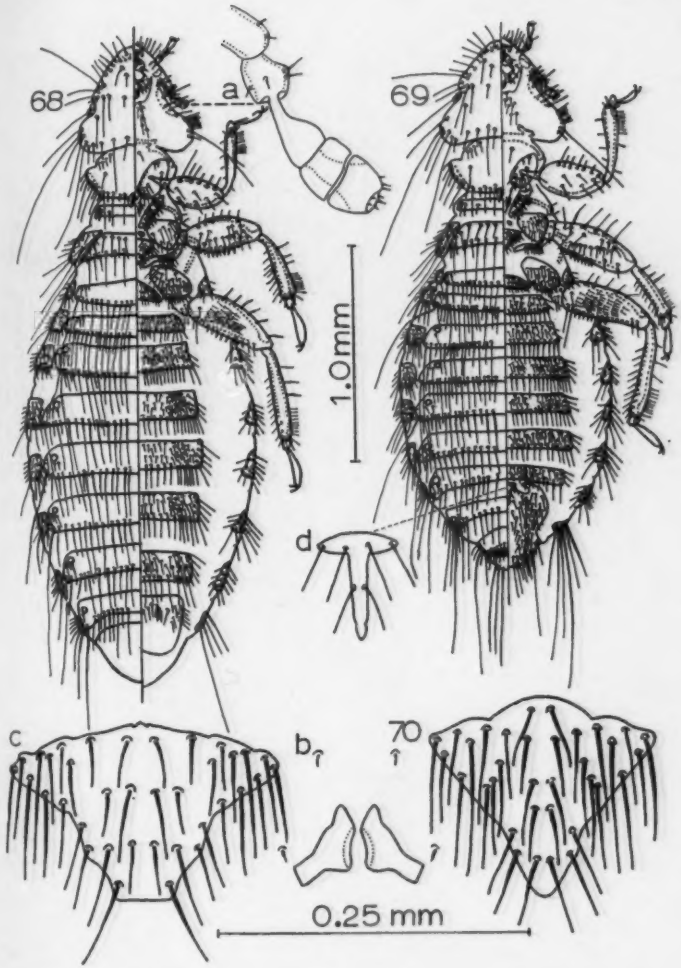
FIGURES 53–63.—Female terminal abdominal segments, dorsal-ventral view: 53, *Bucerophagus productus* (Burmeister); 55, *B. africanus* Bedford. Female anal fringe, ventral view: 54, *B. productus* (Burmeister); 56, *B. africanus* Bedford. Male genitalia, ventral view: 57, *Bucerocolpocephalum emersoni*, new species, holotype; 58, *B. deignani*, new species, holotype; 60, *Bucerophagus forcipatus* (Nitzsch); 62, *B. productus* (Burmeister); 63, *B. africanus* Bedford. Male terminal abdominal segments, dorsal-ventral view: 59, *Bucerocolpocephalum deignani*, new species, holotype; 61, *Bucerophagus productus* (Burmeister).



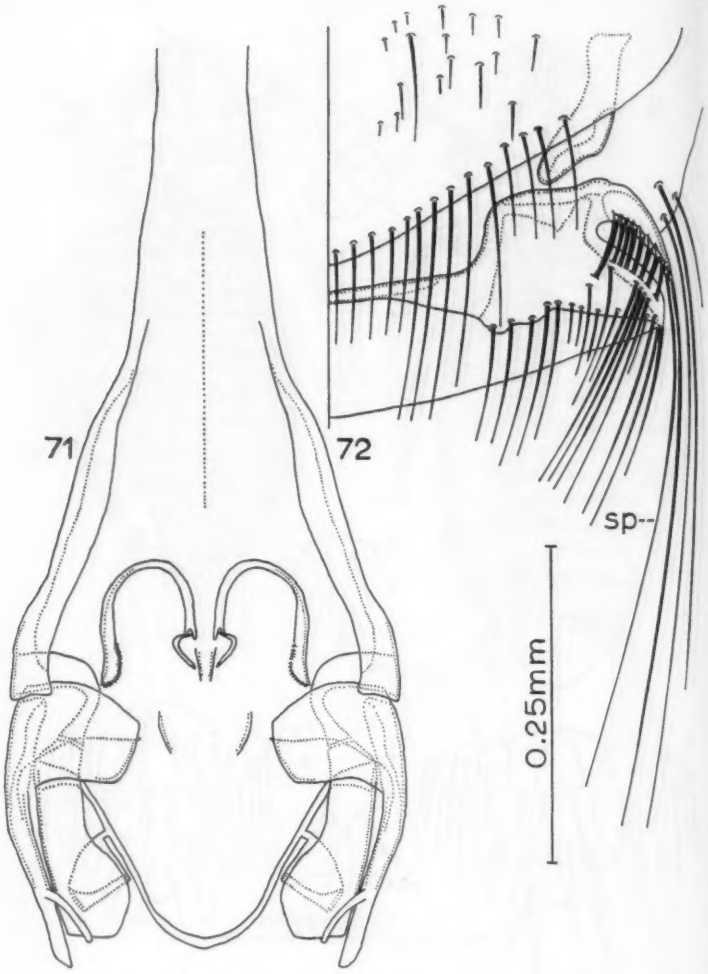
FIGURES 64, 65.—*Bucerocolpocephalum emersoni*, new species, dorsal-ventral view: 64 allotype female; 65, holotype male. (a=antenna of female; b=prosternal plate of female; c=metasternal plate of female; d=first abdominal sternite of female; e=terminal abdominal segments of male; l=short lateral setae between spiracle and postspiracular seta.)



FIGURES 66, 67.—*Bucerophagus forcipatus* (Nitzsch), dorsal-ventral view: 66, female; 67, male. (a=antenna of female; b=prosternal plate of female; c=metasternal plate of female; d=terminal abdominal segments of male.)



FIGURES 68–70.—*Bucerophagus africanus* Bedford, dorsal-ventral view: 68, female; 69, male, (a=antenna of female; b=prosternal plate of female; c=metasternal plate of female; d=central T-shaped plate of male sternite VIII.) *B. productus* (Burmeister): 70. metasternal plate of female.



FIGURES 71, 72.—*Chapinia waniti*, new species, ventral view: 71, genitalia of holotype; 72, terminal abdominal segments of allotype. (sp=posteriorly directed setae on lateral projection of ventral sclerite between vulva and anus.)